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Sources of the Seven-Day Week

By LELAND S. COPELAND

Among the great human mysteries appears a problem only partly solved, the origin of the week. This seven-day cycle has affected the life and conduct of billions of men and women, living and dead. Where and why did it enter civilization?

The day, the month, the year were found in the heavens. Was the week an exception? Or was it, as Laplace believed, "the most ancient monument of astronomical knowledge"? And, if the week was derived from the sky, which celestial body was its source?

Contrary to common belief our week did not come from the Jews, though they gave us the sabbath. While the Anglo-Saxons were still heathen and before they left their Teutonic homes, they with other Germanic peoples had accepted the seven-day week. This venerable time period, recognized by the later Roman empire (beginning in the fourth century A. D.), was introduced into Greece and Rome, either directly from the Tigris-Euphrates valley or indirectly through Alexandria, Graeco-Egyptian metropolis and capital of the ancient scientific world.

The proudest astronomer yields to astrology in one respect; he accepts the list of days evolved by stellar fortune-tellers when they ornamented our week. As astrologers easily misapply facts, we need not wonder that they shuffled the seven days. They ranked sun, moon, and five planets according to the supposed remoteness from earth—Saturn, Jupiter, Mars, Sun, Venus, Mercury, and Moon. Using this order, they gave one of the seven names to each hour of the week. But there were twenty-four hours every day and only seven names; so it was necessary to repeat the list many times. Then astrologers named each day after its first hour and thus obtained the irrational arrangement still accepted today. Just as the path of a wobbly calf, according to Sam Walter Foss, became a city street that thousands travel daily—"for men are prone to go it blind along the calf-paths of the mind"—so we follow the Alexandrian magicians of long ago.

Yet one alteration was introduced. Originally Saturday came first and Friday was the seventh day. Sunday eventually took the lead, perhaps because worshipers of Mithras, god of light, observed Sunday as their holy day, or because Christians, who at first called Sunday the Lord's day in remembrance of the Resurrection, wished it to head the cycle.

As the Romans, in designating the days, had substituted the names of their gods for those of the corresponding Babylonian deities, so the Anglo-Saxons and other Teutons rendered the Latin words in terms of

their own religion. Sun and moon survived the double change, and the classic Saturn continues to hold the seventh day.

* * * *

From the Roman empire we trace the week back through Assyria and Babylonia to Sumeria, one of the two cradles of western civilization. Before the coming of man the Tigris and Euphrates rivers had built up with sedimentary deposits at the head of the Persian gulf the rich Plain of Shinar, land of the Garden of Eden. The Hebrews, one branch of which, according to Genesis, came from Ur in Sumeria, remembered Shinar as the place of plenty, where man had lived in paradise before evil entered the world.

If Sumeria was not, as the Hebrews believed, the birthplace of the human race, at least it was the primary source of our week and of the first principles of our astronomy. In that favored country, where neighboring kings frequently were at war and the arts of peace advanced through several thousand years, priests were astronomers and temples were observatories.

Popular lecturers like to tell that early Babylonian shepherds watched the stars and gave them names. But where astronomical progress is to be made, shepherds are as useless as cowboys. When shepherds, like ruddy-faced David, "consider Thy heavens," only their emotions are stirred; they find beauty, but not knowledge. Men of science, the Sumerian priests, were forefathers of star lore.

Before 2100 B.C., time of Hammurabi, great king and law-giver, these observers on tower temples had chosen seven as the ideal, all-potent number, and thereby taken the first step toward a seven-day week. They also had organized the sky into constellations, discovered the wandering orbs of the zodiac, and, though mistaken at first, probably had discerned that Venus and Mercury, morning as well as evening stars, were two, not four, planets, and so found seven heavenly bodies.

About 2500 B.C. they devised the constellations, transmitted to us through the Greeks, especially Aratus and Ptolemy. The Wagons (Bears), Dragon, Kneeler (Hercules), Perseus and Andromeda, Lion, Bull, Twins, Lyre, Dolphin, Eagle, Centaur, Ship, Scorpion, Claws (Scales), Wolf, Sea-goat, Water-snake, Raven—these and others they laid out on the sky, though the names frequently did not correspond in meaning with those used today.

The Sumerians not only regarded seven as the perfect number, but even recognized seven-day periods, prototypes of the week. As early as 2600 B.C. Gudea, able priest-king of Lagash, built a seven-roomed tower temple and dedicated it with a seven-day festival. He also made a seven-eyed weapon, the seven meaning fullness of power. The Sumerians used seven in exorcising evils and favored seven in temple offerings. Seven-day periods are mentioned also in the Assyro-Babylonian epic of Gilgamish, whose origins go back to the third millenium B.C., or

to Sumerian times. In the account of the flood given by this epic, source of the Genesis story, the deluge storm lasts seven days, the dove is released after seven days, and seven days after the ark grounds Utnapishtim (Noah) disembarks.

Among the Assyro-Babylonians seven was defined as fullness or completion and was used in exorcising and atonement rituals. They recognized, besides a mid-monthly sabbath, an evil or unfavorable day, which came on the seventh, fourteenth, twenty-first, and twenty-eighth of the month; also on the nineteenth (seven times seven or forty-nine days from the first of the preceding month). At least this was the arrangement for two intercalary months, in which, according to a cuneiform calendar, restrictions were imposed on important persons—king, seer, physician. Here commoners seemingly were not affected, though perhaps included in a ban on maledictions.

* * * *

Whence arose this belief in the virtues and ideality of seven? There were no bright street or house lights in Sumeria; the heavens were closer to the early Babylonians than to us, especially to those who watched from the step-tower temples. Their religion was based on nature and one of its chief sources was the sky. So, though we cannot speak certainly, we probably are correct in concluding that the origin of the honor paid to seven and of the seven-day week, of which Sumeria provided the prototype, was astronomical.

The sun gave to the Sumerians a year of 360 days, an error of more than five days that can be forgiven when we remember that those first observers lived north of the tropics, so that the sun for them, as for us, never stood directly overhead. Thus unintentionally the sun furnished our circle of 360 degrees, for it was supposed to travel one degree a day.

Also the moon gave them a month of twenty-nine or thirty days. Did it also determine their week?

Three possible reasons for a seven-day week have been recognized by archeologists and astronomers: (1) the Big Dipper, the Pleiades, and other asterisms composed of seven stars; (2) the lunar phases, averaging 7.4 days; (3) the seven heavenly bodies that travel the zodiac—sun, moon, and the five planets (other than the earth) known to the ancients.

As the first two phenomena would be observed sooner by primitive peoples, including the Sumerians, they seem to be stronger arguments. The third reason probably was recognized, as Dr. Johannes Hehn contends, long after the number seven had become a social power. Because discovery of seven heavenly bodies, including recognition that Venus as morning and evening star is the same planet, requires relatively advanced astronomy, it must have been achieved late in Sumerian history. Dr. Hehn emphasizes that special interest in the seven heavenly bodies was not recorded clearly until the time of Assurbanipal—grandson of Sennacherib of the Isaiah story—or in the seventh century B.C. It seems likely, therefore, that the special sevenhood of sun, moon, and five

planets played only a secondary and corroborative part.

Just as thirteen was an unlucky number long before the Christian era, and just as it gained new meaning after the Last Supper of New Testament story, so the seven heavenly bodies must have given added authority to the number seven and to the seven-day week, besides providing names for the seven days.

If one studies the lunar phases, he may wonder how ancient observers could derive a seven-day period by watching them. Between what is popularly called new moon and the first quarter only about five days elapse; to get a seven-day interval one must count back to the true new moon, when our satellite "has gone to sleep." Further, nearly as many eight-day groups appear as seven-day periods. And from last quarter to the popular new moon are included nine or ten days. Nor is it easy to recognize four forms. The thin crescent and the full moon are obvious, but first and last quarters are not so easy. To confuse the observer there are a thin waning moon, with horns reversed, and two distinctive gibbous shapes. Astronomy must have progressed considerably before four phases — conjunction, opposition, and two quadratures — were established, though this discovery must have antedated that of the seven heavenly bodies.

How, then, could the Sumerians arrive at a seven-day week by watching the moon?

First, when four phases are accepted, the average is about seven days. Second, the most frequent interval is seven. Finally, and more cogent than theory, is the probability that the Sumerians, or at least their early intellectual descendants, used periods of seven for the lunar phases. In the Assyro-Babylonian epic of creation, tablet V, dating from the seventh century B.C. and supposed to include Sumerian material, is the following picture of lunar weeks (the text is rendered freely):

"Then Marduk assigned to the moon god
Control of the night and said:
'Each month your tiara of beauty
Shall shine on the evening's head.
For you shall measure the cycles;
Six days you shall show horns of light;
The seventh your crown shall be finished;
The fourteenth both halves shall be bright.'"

But some scholars believe that the last line, which with the remainder of the passage has been mutilated, should be translated, "On the sabbath both halves shall be bright." This would given an eight-day space between first quarter and full moon, for the Babylonian sabbath was the fifteenth of the lunar month.

* * * *

Closely related to the problem of the seven-day week is the question concerning origin of the sabbath. Enlightened by astronomy and geolo-

gy, we know that heaven and earth were not formed in six days. Archeologists have found that the Babylonians recognized a festival suggestive of the Jewish sabbath, the *sabattu.*

Sabattu or *sapattu* was the time when the moon reached fullness and apparently rested. The word was allied to *sapatu,* Babylonian, "to be complete," and it came from Sumerian *sa-bat,* "heart rest." It was not a holiday for ordinary men, for business was conducted as usual, but a time for giving rest to the heart of the gods by conciliating them, as Ira M. Price explains. The moon and the gods could rest, but man toiled on. This full-moon festival on the fifteenth day was the earliest form of sabbath.

The Hebrew word for sabbath, *shabbath,* is derived from *shabath,* to desist, to rest. It probably was adapted from the Babylonian, though it may have arisen independently, drawn from the same root.

Argument that the full moon was the first Hebrew sabbath has been defended by Meinhold and other scholars. The phrase, "new moon and sabbath," recurs in the Old Testament, especially in the orations of the eighth-century prophets, Isaiah, Hosea, and Amos. Directly or indirectly, they spoke lightly of the sabbath, perhaps because it seemed to have come from Canaanite or Babylonian ritual, as Dr. William F. Badè suggests. Unlike the compiler of Deuteronomy, the reforming prophets seem not to have credited it with humanitarian meaning. Under this theory the seventh-day sabbath was introduced by the Hebrews after the Babylonian exile and was influenced by Chaldean ideas.

But linking of new moon and sabbath could be explained otherwise; they easily could have been joined because they were the only frequent festivals. Also the reformers, as the context in Isaiah suggests, attacked formalism, devotion to the letter of the law. "Let justice roll down as waters," urges Amos, "and righteousness as a mighty stream."

In the story of the Hebrew patriarchs the sabbath is not mentioned, though Abraham migrated from Ur, according to Genesis. Perhaps the sabbath arose independently through lunar observations in the forty years of wilderness wandering. Moon worship, still commemorated in the words Sinai and Wilderness of Sin, may have affected the thinking of Moses in his fugitive years in that region of the full-moon cult. In Exodus the Israelites enter the Wilderness of Sin on the fifteenth day, time of the full moon.

But it should be remembered that Hammurabi, nine hundred years before Joshua, was king of the Amorites as well as of the Babylonians. Perhaps politically, but certainly culturally, Palestine was linked with the two-river country. Hence the laws and traditions of Sumeria must have preceded the Hebrews into Canaan—the magical seven, the seven-day period, and perhaps the seven-day week.

One of the oldest codes recorded in the Bible, the Little Book of the Covenant (Exodus 34, 11-27) prescribes a seventh-day of rest, but does not call it sabbath. In a later digest, the Book of the Covenant (Exodus

20, 22 to 23, 19) the word sabbath again is wanting—"Six days thou shalt do thy work, and on the seventh day thou shalt rest, that thine ox . . . may have rest, and the son of thy handmaid . . . be refreshed." But the post-exilic Code of Holiness (Leviticus 17-26) commands, "Six days shall work be done, but on the seventh day is a sabbath of solemn rest."

So even though the Hebrew sabbath may have been only a mid-monthly festival before the exile, a seventh-day of rest also must have been recognized. In fact, evidence for the seventh-day pause is stronger than for the mid-monthly feast. But the Babylonians had both a sabbath and a restrictive seventh day; so the Hebrews may have recognized both until in time the two were merged. Under guidance of priest and scribe the old sacred days, descended from Sumerian prototypes, evolved into the elaborate and exalted sabbath.

After the Israelites had entered the promised land, they repeatedly fell under the influence of those who had preceded them—"followed the gods of the peoples that were round about them." The conquerors adopted traditions and practices of the Canaanites, whose civilization came partly from Babylonia. Perhaps Amorite customs awoke in the Hebrews a new interest in the perfect number, seven-day periods, and a mid-monthly sabbath.

Numerous references to seven and seven-day cycles can be found in the Old Testament. Seven was favored for festivals, fasting, mourning, purification, and offerings. The power of seven is evidenced especially in the account of the fall of Jericho—seven priests, seven rams' horns, seven days' march around the walls, seven times on the seventh day—and in Hezekiah's sin offering for Judah, seven bullocks, seven rams, seven lambs, seven he-goats.

When the author of Exodus 20, 9-11, urges that the seventh-day sabbath should be observed because heaven and earth were created in a seven-day period, including twenty-four hours of rest, his explanation was sound according to the best light of his age. Already for two thousand years a cycle of seven had been considered ideal for accomplishment of consequential work.

But before that passage was written the source of the seven-day week had been forgotten, just as was the origin of the Passover, a sun festival, of the pagan bull and lamb cults, which resulted from the position of the vernal equinox in Taurus and Aries. So a new reason was found. In fact, two explanations were given, the cosmological in Exodus 20, 9-11, and the humanitarian in Deuteronomy 5, 12-15, each an attempt to interpret a custom whose true origin had melted from Hebrew memory.

* * * *

Like the older lunar craters almost buried under later lava outflows and newer ring mountains, astronomical facts lie hidden behind the faiths and customs of the world. And among these is the seven-day week, whose establishment must have resulted from interplay of three

influences, the seven-starred asterisms, the lunar phases, and the seven heavenly bodies. Advanced knowledge was necessary for recognition of the seven heavenly bodies, and considerable information for acceptance of four phases, averaging about seven days. But no science was required for observing the seven-starred groups.

Clearly outlined on the face of night hangs the Big Dipper. It is so conspicuous that even persons who do not profess to know the constellations can point out these stars, called by the Babylonians the Wagon and by the Romans the Seven Oxen. All peoples in all ages, perhaps even the cavemen, have seen them. Another group is the Pleiades, which as a cluster, has drawn attention through the centuries. The Bear is mentioned by Homer, Hesiod, and Job; the Pleiades by Homer, Job, and Amos. With Orion these were the most popular asterisms of the ancient world.

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STATUES OF MEMBERS OF THE SUMERIAN CULT,

discovered at Tell Asmer, fifty miles northeast of Baghdad, by the Iraq Expedition of the Oriental Institute of the University of Chicago. (Dated about 3000 B.C.)

(The tall figure with the black beard is the Lord of Fertility; the tall female figure is the Mother Goddess; the other statues represent priests and worshipers.)

Other sevens are provided by the Little Dipper and the Northern Crown. How easy it would have been for the Sumerian priests, those large-eyed, long-bearded men whose grotesque statuettes archeologists have unearthed—to have concluded that Anu, god of the heavens, esteemed seven and had revealed in his stars the ideal number. Inspired by this thought, they may have selected additional sevens from Cassiopeia, Lyra, Cygnus, Hercules, Gemini, Virgo, and other configurations; it is easy to find when one is swayed by a fixed idea.

The new moon and the full have given restrictive festivals to primitive peoples, and less frequently the quarters. Four phases must have been recognized before the seven heavenly bodies were grouped. But without continued observation or study the Pleiades, and especially the Big Dipper, tell their story of seven. So if by origin one means the earliest reason, here seemingly is the source of our seven-day week, which received support later from the lunar phases, and finally from sun, moon, and planets, which also gave to the days their names. The erring Hebrews "burned incense to the sun, and to the moon, and to the planets," says the book of II Kings, but that was ages after the starry wagon and the seven sisters had caught the eyes of mankind.

When seven first was rated as a potent, perfect number (before 2600 B.C.), Thuban (Alpha Draconis) was the north star. As a result the Big Dipper was then nearer the north celestial pole and swung through a smaller circle. In those days to hunt for north was to look for the seven brightest stars of Ursa Major, which, even more than today, compelled attention from the humblest as well as the wisest.

In the dawn of history these seven stars began to give us our week. Dubhe, Merak, Phaed, Megrez, Alioth, Mizar, Benetnasch form a group variously called Big Dipper, Wain, Plough, Seven Wise Men of Greece, Seven Sleepers of Ephesus. With Sirius, Gemma of the Northern Crown, and stars in Auriga and Leo, five of them make a cluster through which our sun is traveling slowly. Indirectly they have influenced billions of human lives. Men unknowingly have suffered and died for them. We see them shining boldly on the northern wall of night, but glimpse them dimly, or not at all, through the mists that linger above the morning of civilization.

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The Seneca Township Meteorite

By STUART H. PERRY

The Seneca Township (Michigan) meteorite was obtained by the writer in 1923 and submitted to the late Dr. Charles P. Merrill, who removed about 20 grams for study and published the following brief description with a photograph of one side of the iron:[1]

> This iron was brought to my attention by Stuart H. Perry, of the Adrian *Daily Telegram*, with the statement that it was found in July, 1923, and that it is supposed to be the result of a fall seen in Seneca Township in 1914. The evidence thus far submitted cannot, however, be considered as altogether confirmatory.
>
> As shown in the plate, the mass is in the form of a flattened oval and, though oxidized and scaling somewhat on the outer surface, still shows traces of the original thumb markings. That it has lain exposed for some years is unmistakable. The present weight is 11.5 kilograms. An analysis by E. V. Shannon in the Museum laboratories yielded:
>
> | | |
> |---|---|
> | Iron | 87.77 |
> | Nickel | 11.41 |
> | Cobalt | 0.26 |
> | Copper | 0.01 |
> | Sulphur | 0.05 |
> | Phosphorus | 0.15 |
> | | 99.65 |
>
> No platinum was detected, as the amount of material furnished was insufficient for a satisfactory test. An etched surface shows the iron to be a medium octahedrite; the content of nickel places it in the Rodeo group.

Subsequently additional data became available, fully proving that the fall was observed, and a metallographic study was made by the writer, which make possible a more nearly complete description of this interesting iron.

The fall took place in June, probably in the year 1903, on the farm of Sidney A. Perry, Section 4, Seneca township, Lenawee County, Michigan. Mr. Perry, with his two brothers, witnessed the occurrence which he recalled distinctly and related as follows:

It was about the hour of sunset and they were standing near the farm house which is on a rise of ground and commands a rather wide view to the north and west. It was not yet dark, the air was still, and the western sky was filled with the dark clouds of a distant thunderstorm. Mr. Perry judged that the storm must have been more than 15 miles distant. As they were looking at the sky a brilliant fireball suddenly appeared against the dark background of the clouds.

The spot where it appeared, as fixed by numerous landmarks, was due west from where the observers stood and near the horizon. By sighting along a rod Mr. Perry indicated the spot, which, by measurement, was about 10 degrees above the horizon. It seemed at first to be coming directly toward them and they wondered whether it would strike where

FIGURE 1
ABOVE, CONVEX (FORWARD) SIDE; BELOW, FLAT (REAR) SIDE.

they stood, but as it approached it seemed to move more and more toward the south until its position was about west-southwest of the observers, at which point it ceased to be luminous and was lost to view. Its course was described as parallel with the horizon and so low that it seemed to skim the tops of trees, and at one point even appeared to pass between the observers and a distant tree. It gave a brilliant white light at first, throwing off sparks; then the color changed to red, which became dimmer until it was no longer visible.

They did not hear any detonating sound that they connected with the meteor. Mr. Perry, however, mentioned that once they heard what they supposed was faint thunder from the distant storm.

Mr. Perry said the meteor was visible for two or three seconds. A little later (he said a few seconds but could not estimate the time closely) a noise was heard such as he imagined a cannon ball might make—"a rushing sound with a hiss." The noise ended in a hay field at a point about 150 or 160 yards directly southwest of where the men stood, and at the same instant a sound was heard like that of something striking the earth.

The spot where it was heard to strike was so definitely located with reference to fences, buildings, and other landmarks, that they expected to find it readily when they searched in the meadow the next morning; but because of the uncut hay the search was difficult and nothing was found. They felt certain, however, of the approximate spot, and afterwards whenever work was done in the field a careful watch was kept for anything unusual. In July, 1923, while Louis A. Robin, Mr. Perry's son-in-law, was cultivating corn at the spot where they first searched, the cultivator struck a heavy object which proved to be the meteorite here described.

The evidence seems clearly to establish the circumstances and the approximate date of the fall, and to add one more to the comparatively small number of iron meteorites whose falls have been observed.

The mass (Fig. 1) is lenticular, about 24 by 19 cm in its greatest dimensions with a maximum thickness of 8 cm. The more convex side showing considerable irregularity and pitting, with one especially large concavity, was presumably the forward side in flight. The flatter side is quite regular and evenly covered with very shallow pitting.

The edges are rather sharp in places, and there are no visible fissures or other signs of disruption. The original fusion crust has disappeared save for small remnants of the black magnetic oxide, and the surface has rusted to a dark brown. The rust, however, has penetrated little into the mass.

Several slices were removed from one end, the largest 6 by 18 cm, which reveal a beautiful octahedral structure (Figs. 2, 3, 4). The kamacite bands and many of the fields exhibit a strong oriented sheen, while numerous large eutectiform areas of finely lamellar taenite glisten brilliantly when the light falls crosswise of the structure. The sections do

FIGURE 2
SLICE NATURAL SIZE, MICRO-ETCHED.

not correspond with any of the crystallographic planes, thus giving four sets of bands intersecting at various angles.

On an ordinary etched surface the general structure appears to the eye as strikingly regular, many bands running straight for long distances. Fields predominate strongly, occupying several times the area of the kamacite bands and reaching dimensions of more than a centimeter. The very narrow bands are often single and widely separated, though in some areas they are quite closely spaced. Occasionally they are grouped in fascicles.

Under the microscope the structure appears much less uniform, the bands varying in width or having irregular boundaries, with many short ones at various angles. In the numerous coarse eutectiform areas the arrangement of taenite lamellae often simulates true kamacite bands so deceptively that it is not easy to differentiate between the two structures. Following the course of an apparent band, it may prove to be such or it may merge into a coarse eutectiform structure (Fig. 5). Again an apparent fascicle of grouped bands of equal width may turn out to be a single true band adjacent to a eutectiform area in which the kamacite has the same texture, markings, and sheen as the band itself.

The bands are usually bounded by taenite lamellae, though often there is a lamella on only one side, and sometimes none. In a few places the lamellae have the unusual ragged edges shown in Fig. 6.

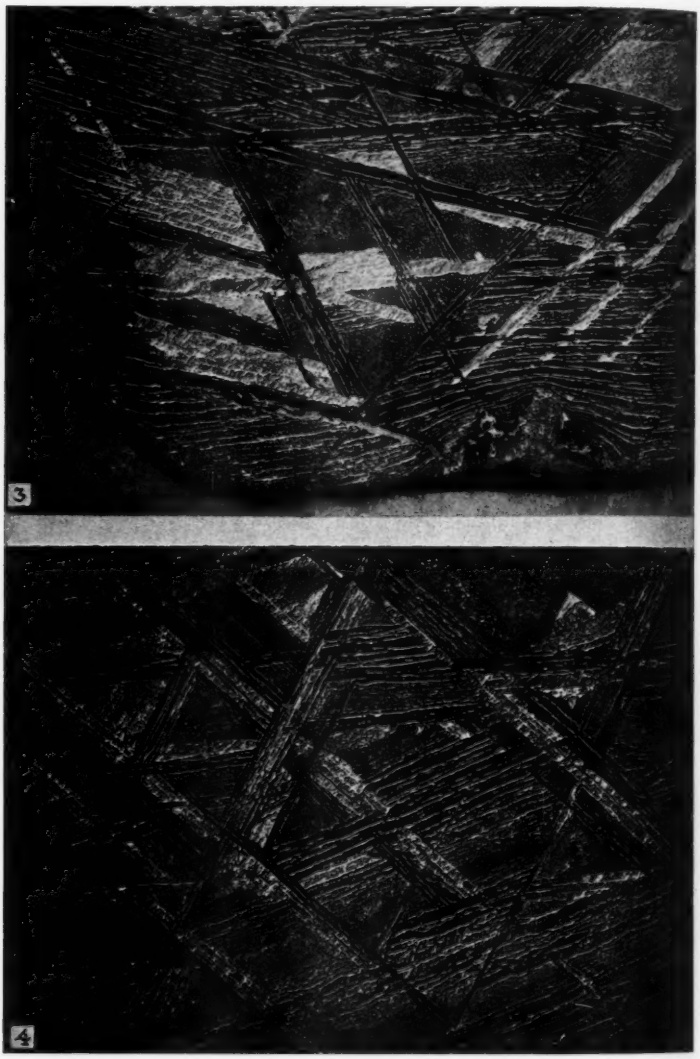
The kamacite, both in bands and in the coarse eutectiform structure referred to, has a strong oriented sheen and is heavily hatched, the markings often being so coarse and densely crowded, frequently in two directions, that the appearance is quite unlike that of Neumann lines as they commonly are observed in octahedral irons.

The very profuse fields present a great diversity of structures, of which two types predominate—a light plessite filled with delicate threads or minute droplets of taenite; and a coarse structure of lamellae approximately parallel with some one of the crystallographic planes. Fields of the latter kind are the most striking feature of this iron, occupying perhaps a quarter of the polished surfaces. Many such areas are filled with fairly long and continuous lamellae, approximately parallel and quite evenly spaced. With ordinary micro-etching such areas glisten brilliantly when light falls at right angles to the lamellae. Some fields are crowded with short disconnected lines of taenite, and there are areas of very fine parallel and continuous threads.

The various types of plessite structure are combined in endless variety, a single field being partly dotted with taenite droplets and partly occupied by a coarse or fine lamellar structure, or surrounded with a border of it.

Dark or micro-plessite does not occur in fields of noticeable size, but is found in small irregular areas or as inclusions in taenite masses.

The coarse eutectiform areas usually have a fibrous appearance, often dense, the nature of which is obscure even under high magnification.

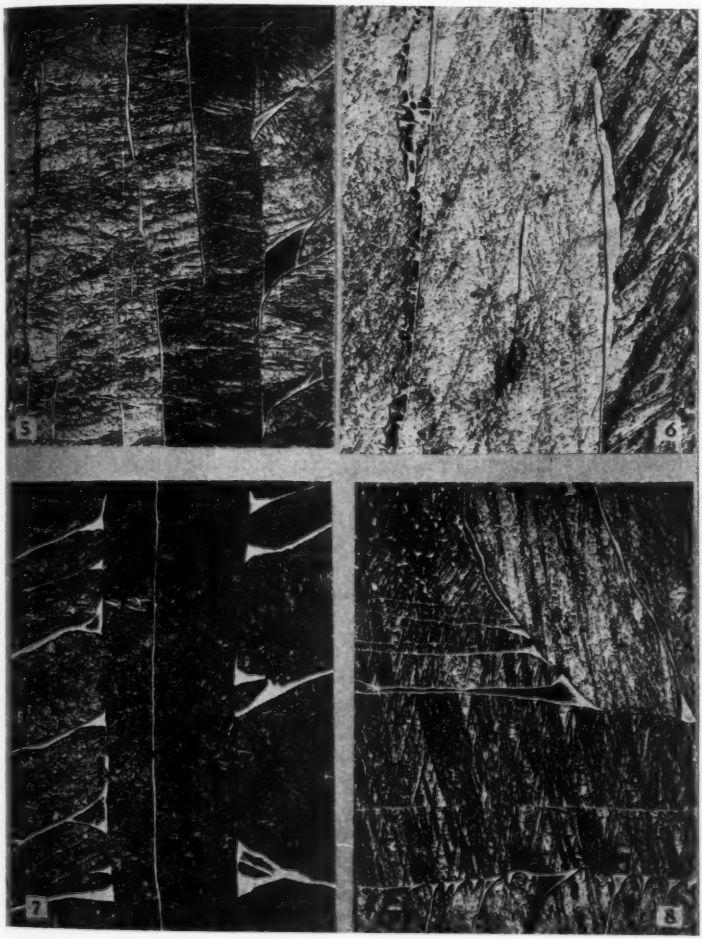


FIGURES 3 AND 4

3. SLICE SHOWING (LOWER EDGE) INTRUSIVE MAGNETIC OXIDE; ×3, LIGHT NITAL ETCH.

4. TYPICAL OF PREVAILING STRUCTURE; ×4, LIGHT NITAL ETCH.

Among the many peculiarities in such areas is the fanlike structure shown in Fig. 15. Another peculiar detail, for which the writer suggests no explanation, is shown in Fig. 16. Its appearance first suggested a stain; but, in addition to its reappearance after repolishing, the details of the photograph negative that supposition.



FIGURES 5, 6, 7, AND 8

5. KAMACITE BAND PARTLY MERGING INTO EUTECTIFORM STRUCTURE; ×65.
6. IRREGULAR TAENITE LAMELLA WITH MICRO-PLESSITE INCLUSIONS; ×65.
7. GRANULATED KAMACITE BAND IN ZONE OF ALTERATION; ×65.
8. THE SAME BAND SHOWN IN FIG. 7 IN THE UNALTERED INTERIOR; ×65.

Along the straighter edge of each slice, corresponding with the flat side of the mass, is a zone of alteration about 5 mm wide. With ordinary etching it is not clearly apparent to the eye. Within this zone the hatching of the kamacite changes to a coarse granulation, the grains sparkling with a strong diversified sheen with oblique illumination (Fig. 7).

Within the zone of alteration at several points are small intrusive masses of magnetic oxide extending 2 or 3 mm from the edge of the slices (Fig. 9), in which small areas of kamacite enveloped by the oxide have undergone a dendritic recrystallization (Figs. 10, 11). As dendritic segregations are produced only by quick solidification from the melted state, it is evident that these small areas were filled for a brief period with a liquid solution of iron and magnetic oxide, the latter having formed on the surface during the meteor's flight.

The molten matter, probably heated far above its melting point, was swept around to the rear side, where its accumulation lasted long enough to invade the mass slightly at certain spots. The curvature of the octahedral structure around a number of such spots suggests the former presence of small troilite masses, which would readily have melted out and thus permitted the entrance of the liquid iron and oxide.

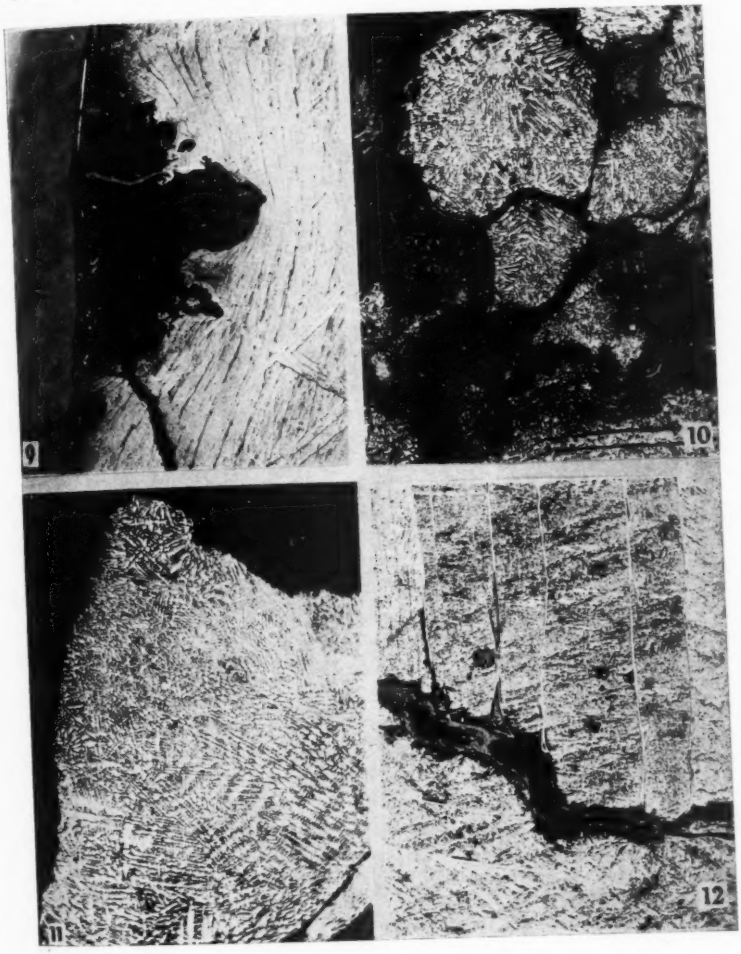
As the liquid cooled, the oxide was rejected in shell-like forms enveloping rounded masses of iron, or as partitions separating such masses, as shown in the illustrations. The subsequent rapid cooling resulted in a dendritic structure oriented with reference to the surrounding oxide, much as dendrites in cast steel often are oriented with respect to the surrounding mould. This extraordinary alteration, observed by the writer in only one other meteorite (Wood's Mountain, N. C.) does not extend into the surrounding iron, which quickly absorbed the heat from the small quantities of invading molten matter; though in places some change is observable in the structure of the iron immediately contiguous to oxide areas.

The boundaries of such oxide areas are clear-cut and their contours rounded, reflecting a quick invasion and solidification of the magnetic oxide, in contrast with the ragged appearance where the hydroxide produced by weathering has gradually penetrated (Fig. 13).

The slices show numerous fine cracks extending inward as much as 2 cm from their rounded edges, and a few in the interior which do not reach the edge. Those starting from the edge are all on the convex side of the mass. The cracks take zigzag courses, following the crystallographic planes, and are filled with magnetic oxide, which presents the same sharp boundaries as the larger intrusive masses previously referred to (Fig. 12).

On the five polished surfaces examined there are about a dozen small troilite inclusions of varying shape the largest being about 3 mm in length. One such inclusion (Fig. 14) is remarkable in that it presents a distinct cross-section of an hexagonal crystal nearly 3 mm in diameter,

three of the sides and angles being quite perfect. At least 5 of the 6 sides are not parallel with any of the kamacite bands. It would, in fact, be merely a coincidence if there were any apparent relation between the crystallographic planes of the troilite and the iron, inasmuch as the

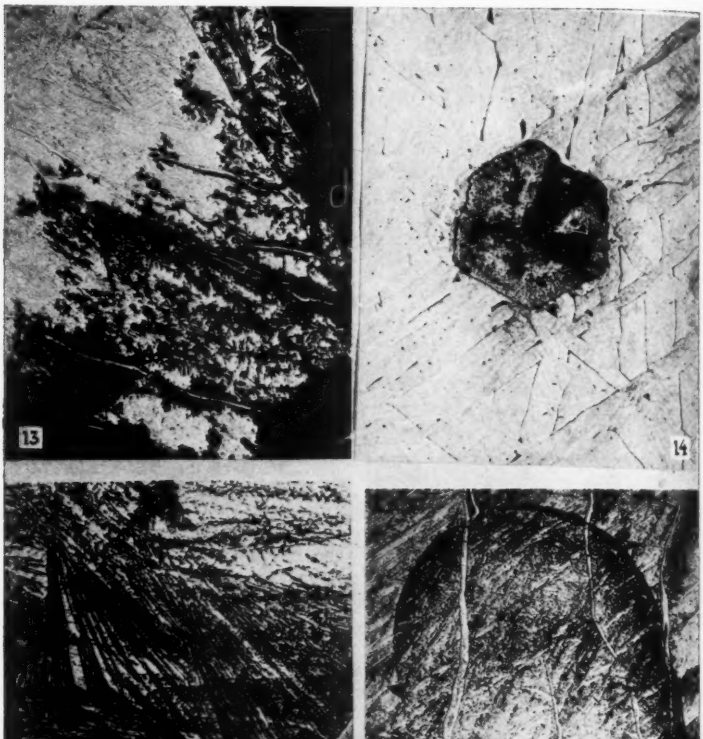


FIGURES 9, 10, 11, AND 12

9. MINUTE AREAS OF IRON SURROUNDED BY INTRUSIVE OXIDE; ×10, ORDINARY LIGHT.
10. DENDRITIC RECRYSTALLIZATION IN AREA SHOWN IN FIG. 9; ×65.
11. ANOTHER AREA SIMILAR TO FIG. 10; ×65.
12. CRACK FILLED WITH INTRUSIVE MAGNETIC OXIDE; ×65.

octahedral structure developed after the troilite segregation was completed.

The writer is not aware of any other reported instance of a clearly defined microscopic crystal of troilite. The few recognizable crystals that have been mentioned by writers have been very small, mostly occurring



FIGURES 13, 14, 15, AND 16

13. HYDROXIDE INVADING A COARSE EUTECTIFORM AREA; ×65.
14. TROILITE CRYSTAL, LIGHT MACRO-ETCH WITH PICRAL; ×10.
15. ANOMALOUS STRUCTURE IN A COARSE EUTECTIFORM AREA; ×230.
16. ANOMALOUS STRUCTURE IN EUTECTIFORM AREA; ×65.

in druses in stony meteorites. Rose found a number of measurable angles in such crystals of troilite from Juvinas, by which he established its hexagonal habit. Meunier found a grain showing some indices of crystallization in the Emmett County meteorite[2] and small crystals, not measurable, have been found in a few other meteorites.[3]

No swathing kamacite (Wickelkamazit) appears around any of the troilite inclusions. Though some iron must have been rejected from them during the cooling of the iron-sulphide solid solution after the octahedral crystallization was established, the inclusions were too small to produce the visible bands of kamacite such as commonly surround larger masses of troilite.

Dr. Merrill lacked material for a petrographic study of this iron, but he noted that its composition corresponded with that of the Rodeo group of fine octahedrites. In consideration, however, of chemical composition, width of bands, and the general characteristics of structure, the writer is inclined to classify it as a finest octahedrite (Off).

Of a large number of bands measured, 20 per cent were less than 0.2 mm wide, 40 per cent were between 0.2 and 0.25 mm, 30 per cent from 0.25 to 0.3 mm; the rest exceeded the last figure or were irregular. Though Brezina set 0.2 as the maximum for finest octahedrites, Cohen[4] places greater emphasis on the development of fields, and defines that group as embracing irons in which plessite is very strongly developed, with bands normally up to 0.25 wide, exceptionally somewhat wider.

Of Cohen's two groups of finest octahedrites, Tazewell and Salt River, the latter is distinguished from the former by its lower nickel content (not more than 10.25 per cent) and by the extreme predominance of fields—the plessite forming a groundmass in which the kamacite bands are embedded, rather than a "Fülleisen" strictly so called. The iron here described exhibits these characteristics, rather than those of the Rodeo group as stated by Cohen—namely, fields equal in area to the bands, bands 0.25 and 0.5 mm wide, nickel 8 to 10 per cent, and almost invariably much dense dark plessite.

On the other hand this iron bears a striking resemblance to the Mungindi iron, placed by Cohen in the Tazewell group, of which an excellent illustration is given by Pfann.[5]

The main mass of the Seneca Township iron has been given by the writer to the United States National Museum.

REFERENCES

[1] *Proc. U. S. Nat. Museum*, Vol. 72, Art. 4.

[2] *Météorites*, 62.

[3] *Meteoritenkunde*, I, 190, 201.

[4] *Meteoritenkunde*, III, 253, 272.

[5] "Über die inneren Gefügebau der meteorischen Nickeleisen," *Int. Zeits. f. Metallographie*, Bd. IX, Tafel II; 1917. See also Cohen's description of Mungindi.

Sphaera Mundi
(Quotations and Comments)

By ERICH TAYLOR

In a second-hand bookshop recently I discovered an old volume, clumsily rebound in ill-matched leathers, and marked on the outside "Sphaera Mundi." The inside proved even more interesting, bearing a half obliterated stamp "Trinity College Dublin Duplicate Sold." And the title page was elegant with Latin inscriptions grouped above the printer's mark; an oyster shell upon the beach containing seven large pearls, beyond it the sea, above the sea a mist of falling rain, above the rain a cloud encircling the name of God and to the heraldic right, I might say the Gospel side, the sun in splendor—the whole inscribed with a motto "Gratia Dei Mecum," (The Grace of God be with me). The author's name given was Joseph Blanco of Bononia, a member of the Society of Jesus. It was printed at Modena by Julian Cassiani in 1635.

The night before my visit to the bookstore, I had had the pleasure of gazing with a friend through his 6-inch reflector (constructed by himself in his spare time from making standard cells, pyrheliometers, and the like). The object of our gaze was Saturn; Newton was part of the subject of our talk. The title of the old book "Sphere of the World" seemed appropriate and the wood-cut with its "pearl oyster shell" reminded me of Newton's simile of himself as a "picker up of shells on the sea-shore."

A brief perusal of the book brought to light that it adhered to the Ptolemaic system (as did Milton in Paradise Lost), sanctified by Dante and the scholastics. The heliocentric idea of Copernicus is mentioned but only to be set aside. "This ancient belief (the sun the center and the earth moving about it) was stirred up again to life in the past century by Nicholas Copernicus, a man of sharp mind and a great restorer of the science of Astronomy. He even defended it against the argument of other men, so that today some few mathematicians of good repute, as for example, Jo. Kepler, William Gilbert (author of "De magnetica philosophia"), and others, support the same unfortunate view. Other mathematicians, indeed all the others, reject this view as absurd. Copernicus actually added that not only is the earth itself moved in the ecliptic, but together with the earth, the water and the air and all the "interlunary" sphere, in just the same proportion as the earth moves, by which hypothesis not only do Copernicus and his followers seek to save appearances but also believe they easily escape the counter-arguments of their opponents.

"For all that, however, this opinion is false and must be rejected, as is manifest by reasons given formerly and by many opinions of authori-

ties; all the more because it has been forbidden by the ecclesiastical authorities as contrary to Holy Writ."

Turning over a few pages, I came to the account of Jupiter, the planet, and found a chapter entitled "De quattuor novis planetis Jovis Comitibus" (Concerning the four new planets that are companions to Jupiter). "It is a remarkable and happy discovery, which through the power of the Telescopium has been laid bare, that Jupiter is companioned. And indeed perpetually there are about him four little stars (stellulae) or tiny planets, running courses around him, as we show in our figure [the figure shows the satellites well and the conical shadow of the planet in which they are at times eclipsed]. It is thus that we see them on a clear night through the Telescopium directed at Jupiter, and, as we look, we see near the planet, sometimes one, sometimes two or three, at times even four, of these little stars bearing the planet company, which could not be were these fixed and not moving stars. Sometimes too they appear nearer and sometimes farther from the planet, which is only possible if we suppose that they trace circles about Jupiter, just as Mercury and Venus revolve about the sun. . . . See the 'Stars' Messenger' and the account by Galileo of the Sun Spots, as also the Remarks (Disquisitiones) of P. Christopher Scheiner of our Society, where these matters are treated at length in the happiest manner. But forsooth he, who discovered them first to the World, was Galileo and he has named them 'medica sydera' (drug stars, one supposes; though perhaps 'magic stars')."

But a few pages farther Saturn is discussed. It too is accompanied by a diagram. "It is indeed wonderful what things the Astronomers of our day, through the marvellous Telescopium, have discovered, and been amazed at, concerning the planet Saturn. They are decided that he is accompanied by two small companions, like to Jove's four, which are arranged in line parallel to the Equator, as the companions of Jove are parallel to the Eclyptic. At times they are so very close to Saturn as not to be distinguished from him, but make the planet appear oval, as in figure A. Sometimes as in B they are clearly distinguishable from him, or as in C. But the most wonderful of all is that Galileo and others watched them continually for two years and more, after which time they vanished and I hear no more of what happened to them. This unexpected disappearance holds the observers thunder-struck and full of wonder. But I myself at the end of October in the year of 1616 saw the planet oval but with two round spots at each of its extensions, just as it is drawn in figure A, in which state it has remained right up to this month of November 1619, when this was printed. See Galileo in his book on Sun Spots (toward the end) and also the Disquisitiones Mathematicae of Father Christopher Scheiner of our Society."

"Truditur dies die, Novaeque pergunt interire Lunae"[1] (Day cuts off

[1]*Horace*, Carm. II, xviii.

day, and the moons, once new, drive haughtily on to destruction). As I read that astronomer's words of three hundred years ago, I was struck with the alert eagerness of his mind, fettered perhaps by academic tradition and punctilious Bibliolatry, but keen and ready to discover and press forward with the Truth. I was reminded of the school of "modern" scientists who still reject Relativity.

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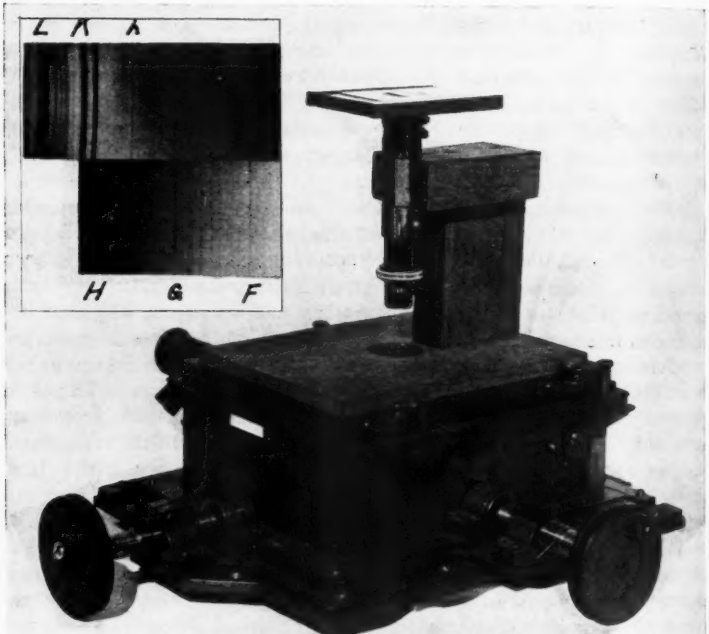
An Astronomical Spectrograph for the Amateur

By ARTHUR ADEL

The spectrograph reproduced in the accompanying photograph is essentially a Bausch and Lomb direct vision, pocket spectrograph, to the eye-end of which there has been added a simple lens of aperture f:2 and



An Astronomical Spectrograph

L, 3820 angstroms; K, 3934; h, 4102; H, 3969; G, 4308; F, 4861.

a small plate-holder.

The camera thus formed is both fast and possesses a useful dispersion as revealed by the sky spectra reproduced in the figure.

For following fine detail in the image of the moon and for accurate guiding in general, the spectrograph may be mounted in a double-slide plate-holder as illustrated.

LOWELL OBSERVATORY, FLAGSTAFF, ARIZONA.

A Rapid Method of Making a Schmidt Correcting Lens

By ARTHUR DeVANY

The most difficult task facing the maker of a Schmidt camera is the making of the correcting lens. Many persons who would like to make cameras of this type have been discouraged by the few methods available for testing the correcting plate while it is under construction. Two methods have been offered: one by measuring with a dial indicator the variation of thickness of the lens while grinding to a form previously determined by mathematical formulae, the other by grinding and polishing before each optical test. The former method requires an expensive dial indicator; the latter method is extremely tedious.

The method presented here suffers from neither of these disadvantages. The only materials required are a piece of copper screen wire, a little kerosene and a flashlight. In Figure 1 is shown the principle of

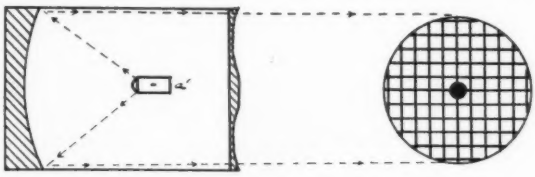


FIGURE 1

ARRANGEMENTS FOR TESTING AND THE PATTERN SHOWN BY A PERFECT PLATE

the method. The screen is bent so that it would fit snugly against a sphere of radius equal to the focal length of the mirror and is then placed at the focus of the aluminized mirror with its convex side toward the mirror. It is not absolutely essential that the wire screen should be bent since only a few strands are used. If this wire screen, so placed, be illuminated from behind with a flashlight and if, with the correcting lens in place, the system be viewed from a distance, the presence of a pattern of straight lines bounding squares of equal area is proof that the correcting lens is perfect. If there are bad zones in the lens, the pattern from the screen will show their locations at once and indicate whether

they are over-corrected or under-corrected. When the lines bow away from the center of the lens, as in Figure 2, the lens is under-corrected.

FIGURE 2
PATTERN SHOWN BY AN UNDER-CORRECTED PLATE

FIGURE 3
PATTERN SHOWN BY AN OVER-CORRECTED PLATE

When they bow towards the center as in Figure 3, (not unlike a chart of the globe with longitude and latitude lines upon it), the lens is over-corrected. Sometimes all conditions are found simultaneously on the same lens, as in Figure 4, but one should remember the rule just given

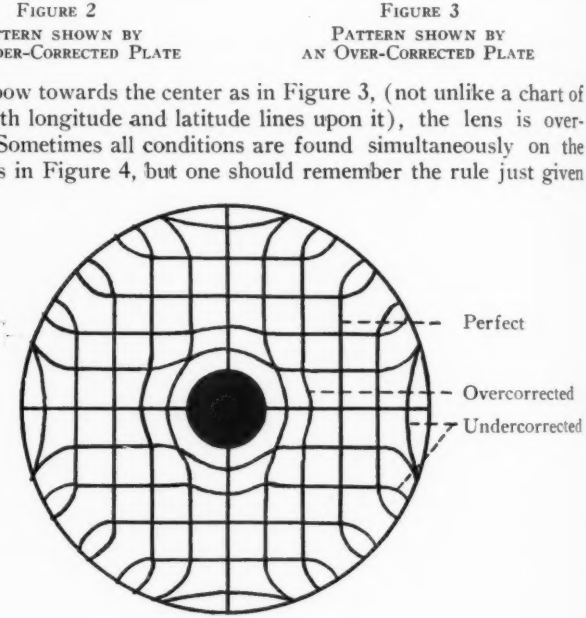


FIGURE 4
THE PATTERN SHOWN BY A PLATE WITH ALL THREE TYPES OF ZONES

when observing the traces of the lines across the different areas of the lens.

The glass used should be good clear colorless plate about three sixteenths of an inch thick. A piece showing a slight yellow tint when

viewed edgewise is preferable to a green piece. The latter will turn yellow in time anyway. The blank should be an inch and a half greater in diameter than is desired in the final lens, for the turned-up edge required is extremely difficult to achieve. If you are lucky, you will have a faster camera than you planned; in any case, you will be glad you have the extra glass at the edge. One side should be tested for evenness of its curve, either by use of a flat or by setting it up as a diagonal in front of a spherical mirror. If it happens to be flat, you are fortunate; if it is slightly concave or convex it does not matter so long as it has a true curve. The other side is ground on lead washers placed on a sponge rubber disk in a single ring about one-third of the way in from the edge. A sink plunger with a small handle is stuck to the glass and is rotated in the fashion in which a Boy Scout drills a fire. The grinding is done with No. 280 carborundum and is continued until a straight edge placed across the glass teeters back and forth slightly. The shape obtained will be convex at the center and concave at the edges.

Now we come to the main point of this method. As indicated in Figure 1, the ground lens is placed in its proper position at the center of curvature of the mirror and the copper screen at the film holder's position. This is lighted up, directly or indirectly, by a flashlight. The lens is wetted with kerosene and the pattern observed. After grinding with No. 280 carborundum, one can see the pattern only faintly at a distance of four feet. One should attempt to straighten all of the lines bowed by under-correction. To understand clearly what is meant by under-correction, one should set up the primary mirror and screen as previously indicated, omitting the correcting plate. One should then light up the screen and observe at different distances from the set-up. At four feet distance, the pattern will be seen as a simple array of lines bowed away from the center as in Figure 2; as one backs away, the pattern begins to form circles near the edges and develops into a very beautiful geometrical pattern. One would, of course, obtain the same results if one placed a polished plane parallel disk of glass at the position usually occupied by the correcting lens.

It will be hardest to achieve the proper form at the edge of the correcting lens; hence while being tested, the lens should be masked down to the diameter desired when the lens is completed.

When testing shows that the lens is under-corrected by only a small amount, one changes from No. 280 carborundum to the next finer grade. The major portion of the correction can now be accomplished. The finer the carborundum used, the better the pattern can be observed. The farther away one moves, the more critical the test becomes. When the finishing emery stage is reached, a finer screen is substituted and the set-up observed from a distance of 75 feet using a small sighting telescope with fine cross-hairs. In a screen there is usually one set of wires which are quite straight while those of the other set are wavy. One can overcome this difficulty by using the straight set and ignoring the other

set. One might use a Ronchi test, but one can judge zones better with two sets of lines at right angles to each other than with a single set alone.

Nothing has been said so far about how to correct under-corrected and over-corrected zones. They are usually found near the center and they can be taken care of by placing the washers a little past the zones and grinding until these zones show straight lines and equal areas in the test.

The polishing is done with a sponge pad the same size as the plate, covered with half-inch squares of honeycomb. These squares are placed in position after the sponge pad has been heated just enough to melt the lower sides of the squares but not the upper sides. The completed polishing tool is not unlike the regular mirror polishing lap but the squares of wax should be entirely free, one from another, so as not to destroy the flexibility of the sponge rubber pad. The center begins to polish first and the edge last. The zones are watched and the lap made up to care for each condition arising just as is done in fine grinding. A wavy polish will sometimes result if very much polishing is needed; in such a case, the polishing should be finished on a slightly waxed lap of melted HCF.

MISSISSIPPI VALLEY OBSERVATORY,
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Planet Notes for May, 1939

By R. S. ZUG

NOTE: Greenwich Civil Time is employed unless otherwise stated. To obtain Eastern Standard Time subtract 5 hours, Central Standard Time, 6 hours, etc. The planetary phenomena are described as they are to be seen from latitude 45° N. The data are taken chiefly from the *American Ephemeris and Nautical Almanac*.

Sun. The positions of the sun for May 1 and May 31, respectively, are:

$\alpha = 2^h\ 29^m.3$, $\delta = +14°\ 44'.1$; $\alpha = 4^h\ 27^m.7$, $\delta = +21°\ 45'.1$.

The sun is in the constellation Aries during the first part of May, entering the constellation Taurus May 15. Values for the equation of time are as follows:

Date 1939	Equation of Time (Mean - Apparent) m s	Date 1939	Equation of Time (Mean - Apparent) m s
May 3	— 3 2	May 19	— 3 41
7	— 3 25	23	— 3 28
11	— 3 40	27	— 3 7
15	— 3 45	31	— 2 38

Moon. Phenomena of the moon will occur as follows:

		h	m
Full Moon	May 3	15	15
Last Quarter	11	10	40
New Moon	19	4	25
First Quarter	25	23	20
Apogee	11	5	
Perigee	23	12	

Eclipses. A total eclipse of the moon will occur May 3, invisible from North and South America, except Alaska, where the beginning of the eclipse is visible. The moon first touches the umbra of the earth on May 3, $13^h\,27^m6$ G.C.T., or $3^h\,27^m6$ A.M. Standard Time, at Seward, Alaska. At this station the moon will be about 5° above the horizon at first contact with the umbra, and will set during totality. Circumstances of the eclipse, and additional information, are given in POPULAR ASTRONOMY, Vol. 47, pp. 29, 30, or may be had by reference to the *American Ephemeris and Nautical Almanac,* for 1939.

Mercury. Mercury is a morning star, and will be at greatest western elongation on May 1. The elongation and magnitude on that date are, respectively, 26° 55′, and +0.7. The elongation is unfavorable in the north temperate zones, but very favorable for observers in the southern hemisphere. As seen from the southern hemisphere, the planet will have attained an altitude of almost 25° by time of sunrise on May 1.

Venus. Venus is a morning star during May. Its distance from the earth will be 138,000,000 miles by the end of the month. The stellar magnitude remains about −3.4, while the angular diameter varies from 12″7 on May 1 to 11″3 on June 1. About 85% of the illuminated hemisphere is to be seen from the earth. Venus will be in conjunction with, and 34′ north of, the planet Saturn on May 16, 21^h.

Mars. Mars rises shortly before midnight during May. Its eastward apparent motion will carry it from the constellation Sagittarius into Capricornus during the month. Data of interest to observers are tabulated below:

Date 1939	Distance from earth (miles)	Angular Diameter	Stellar Magnitude
May 1	76,693,000	11″3	−0.2
June 1	55,310,000	15.7	−1.2

Jupiter. This planet is to be found in the morning sky, moving eastward in apparent motion. On May 9 the planet will be situated 1°2 directly south of the vernal equinox.

Saturn. Saturn is a morning object of stellar magnitude +0.7, and is to be found in the constellation Pisces just before sunrise.

Uranus. Uranus will be in conjunction with the sun on May 9.

Neptune. Neptune is well placed for evening observation, crossing the meridian shortly after sunset. The planet is located near the eastern boundary of the constellation Leo. A chart illustrating the apparent motion of Neptune appeared in the January issue of POPULAR ASTRONOMY, p. 36, arranged for use with an inverting telescope.

Asteroid Notes

By HUGH S. RICE

It happens that at this time, there are no bright asteroids in a convenient position to be observed with small telescopes. Ceres and Pallas will not be "ready" until autumn. Juno is in Aquarius and does not rise until very late, and Vesta is not in a good position until July.

The only other good minor planets available in April and May are Daphne and Thalia. The ephemerides of these we are giving here. They were computed by the Astronomisches Rechen-Institut, at Berlin. There are many other planets

whose ephemerides are computed for the April-May period, but they are faint and range in magnitude from 10 to 17.

Planet 41 Daphne comes to opposition on April 13, and the magnitude is 8.6. On March 29 it is immediately southeast of the star ζ Virginis, almost on the celestial equator, and, after being in conjunction with this star, it proceeds to a position about 2½° north of σ Virginis where it can be found on May 3.

41 DAPHNE (8M.6)

		α h m	δ ° ′
Mar.	30	13 33.1	— 0 19
April	7	13 29.2	+ 1 53
	15	13 24.8	+ 4 0
	23	13 20.5	+ 5 54
May	1	13 16.9	+ 7 29

23 THALIA (10M.0)

		α h m	δ ° ′
Mar.	30	14 7.3	+ 0 40
April	7	14 0.2	+ 1 2
	15	13 52.3	+ 1 19
	23	13 44.4	+ 1 27
May	1	13 37.0	+ 1 25
	9	13 30.8	+ 1 11

23 Thalia is another asteroid in Virgo; the magnitude is 10.0. On March 29 its position is 2½° southeast of τ Virginis, from which it goes to a point 1½° north of ζ Virginis, by May 7. Its motion is therefore almost directly westward, whereas Daphne moves nearly northward.

A year from now Hermes will "visit" the earth, but will not approach as near to us as in 1937.

Hayden Planetarium, American Museum of Natural History,
New York City, March 16, 1939.

Occultation Predictions

(Taken from the *American Ephemeris*)

OCCULTATIONS VISIBLE IN LONGITUDE +72° 30′, LATITUDE +42° 30′.

Date 1939		Star	Mag.	IMMERSION Greenwich C.T. h m	IMMERSION a m	IMMERSION b m	IMMERSION Angle E from N °	EMERSION Greenwich C.T. h m	EMERSION a m	EMERSION b m	EMERSION Angle E from N °
May	2	α Vir	1.2	5 2.9	—2.1	+0.1	64	5 56.3	—1.1	—2.5	337
	5	ν Sco	4.3	5 16.5	—2.4	+1.7	52	6 13.7	—1.6	—1.7	328
	6	109 B.Oph	6.2	3 49.5	—0.7	0.0	132	4 53.1	—1.9	+1.6	244
	7	16 G.Sgr	6.5	4 40.8	—0.6	—0.6	145	5 28.3	—2.1	+2.6	220
	8	BD—18°5155	6.3	9 25.1	—1.6	+0.8	45	10 40.4	—2.1	—1.4	286
	23	68 Gem	5.1	1 21.8	—0.2	—1.7	116	2 16.4	0.0	—1.3	275
	26	p^5 Leo	5.4	23 22.9	—1.6	—0.8	120	0 41.3	—1.6	—1.2	297
	28	78 B.Vir	6.5	4 14.8	—0.8	—1.9	128	5 17.5	—0.6	—1.5	274
	29	50 Vir	6.2	5 43.5	—0.8	—2.1	137	6 38.1	—0.3	—1.1	256

OCCULTATIONS VISIBLE IN LONGITUDE +91° 0′, LATITUDE +40° 0′.

May	2	α Vir	1.2	4 21.3	—2.1	+0.1	94	5 37.3	—1.5	—1.5	315
	5	ν Sco	4.3	4 34.4	—1.6	+1.4	80	5 47.0	—1.4	—0.3	306
	6	109 B.Oph	6.2	3 55.4	..	..	181	4 5.0	..	..	197
	7	39 G.Sgr	6.3	11 19.8	—1.4	—0.3	69	12 37.5	—1.2	—1.2	268
	8	BD—18°5155	6.3	8 47.2	—2.0	+2.0	40	9 58.6	—2.6	—1.0	300
	23	68 Gem	5.1	1 22.3	—0.3	—2.4	142	2 13.4	—0.8	—0.8	253
	25	ω Leo	5.5	1 1.8	—2.1	—0.2	76	1 58.9	—0.6	—2.8	334
	28	78 B.Vir	6.5	4 0.8	—1.1	—2.2	146	5 3.4	—1.4	—1.0	263
	29	50 Vir	6.2	5 30.9	—1.1	—2.3	147	6 28.3	—1.1	—0.9	253

OCCULTATIONS VISIBLE IN LONGITUDE +120° 0′, LATITUDE +36° 0′.

May	1	χ Vir	4.8	9 41.7	..	..	175	10 10.1	..	..	226
	2	α Vir	1.2	3 42.4	−0.6	−1.0	146	4 46.1	−1.9	+0.9	266
	5	χ Oph	4.6	11 40.5	−2.1	−2.4	137	12 35.6	−0.9	+0.6	224
	7	39 G.Sgr	6.3	10 19.1	−2.4	+1.3	61	11 46.0	−2.6	−0.8	288
	8	BD−18°5155	6.3	7 47.3	−1.2	+2.1	64	8 58.7	−1.3	+0.4	291
	27	388 B.Leo	6.3	7 31.0	−0.4	−2.7	158	8 13.6	−0.5	−0.5	246

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

Occultation of Spica on May 1-2, 1939

DATA FOR COMPUTING TIMES

Phase	Date (1939)	T_0 (GCT)	A_T	B_T	C_T	D_T	E_T	F_T	G_T	H_T
			$\lambda_0 = +82° 0'$, $\phi_0 = +39° 0'$							
		h m	m	m	m	m	m	m	m	m
Immersion	May 2	4 41.3	−218	− 8	+ 4	+ 4	+35	−1	+4	+2
Emersion	May 2	5 52.2	−142	−194	−10	+50	−13	+6	+6	−4
			$\lambda_0 = +110° 0'$, $\phi_0 = +39° 0'$							
Immersion	May 2	3 50.0	−120	−22	+24	−25	+61	−9	+19	+5
Emersion	May 2	5 6.1	−175	−10	0	+82	−26	+6	−19	−7

DATA FOR COMPUTING POSITION ANGLES

Phase	P_0	A_P	B_P	C_P	D_P	E_P
	$\lambda_0 = +82° 0'$, $\phi_0 = +39° 0'$					
Immersion	85°	+123°	−236°	+ 8°	+ 3°	0°
Emersion	321	− 86	+216	−13	−14	− 3
	$\lambda_0 = +110° 0'$, $\phi_0 = +39° 0'$					
Immersion	123	+131	−282	− 3	−54	+23
Emersion	289	−133	+246	− 5	+55	−25

The occultation of the first magnitude star Spica on the night of May 1-2, 1939, will be favorably placed for observation throughout the United States. In the extreme northwest, immersion will occur shortly after sunset; but since the star is so bright, observations should be possible even there. In the rest of the country the times and altitudes at both phases will be as good as could be expected over such a large area.

The tables above give data which furnish a means of readily obtaining the times and position angles at immersion and emersion accurate to within $1^m.5$ and 8°, respectively, for a point in longitude λ, latitude φ, where the following conditions are fulfilled, D being the duration obtained by subtracting the time of immersion from that of emersion when the values found from the formula for the times, which is to be given below, are used:

1. $|\lambda - \lambda_0| \leq 14°.0$; $|\phi - \phi_0| \leq 10°.0$.
2. $D \geqslant 30^m.0$.

Then the required Greenwich Civil Times $T(\lambda,\phi)$ and position angles $P(\lambda,\phi)$, measured from the north point of the moon's limb toward the east, are given by

$$\begin{aligned} T(\lambda,\phi) = T_0 &+ 10^{-2}[A_T(\lambda-\lambda_0) + B_T(\phi-\phi_0)] \\ &+ 10^{-3}[C_T(\lambda-\lambda_0)^2 + D_T(\lambda-\lambda_0)(\phi-\phi_0) + E_T(\phi-\phi_0)^2] \\ &+ 10^{-4}[F_T(\lambda-\lambda_0)^2(\phi-\phi_0) + G_T(\lambda-\lambda_0)(\phi-\phi_0)^2] \\ &+ 10^{-5}[H_T(\lambda-\lambda_0)^2(\phi-\phi_0)^2] \\ P(\lambda,\phi) = P_0 &+ 10^{-2}[A_P(\lambda-\lambda_0) + B_P(\phi-\phi_0)] \\ &+ 10^{-3}[C_P(\lambda-\lambda_0)^2 + D_P(\lambda-\lambda_0)(\phi-\phi_0) + E_P(\phi-\phi_0)^2] \end{aligned}$$

where $(\lambda-\lambda_0)$ and $(\phi-\phi_0)$ must be reckoned in degrees and tenths of a degree.

If condition (1), above, is satisfied but $0^m0 \leq D < 30^m0$, the results given by this method should be regarded as inaccurate; on the other hand if condition (1) is satisfied but $D < 0^m0$, the occultation should not be expected at the given place, though it may occur with a brief duration. Rapidly increasing errors must be expected if one applies these formulas to points at greater and greater distances outside the region defined by (1).

JACOB HERRMANN.

Route 3, Box 105, Kenosha, Wisconsin.

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By **CHARLES P. OLIVIER, President**

A splendid fireball with a long-endurng train was reported from three ships, on 1939 January 11/12, as follows:

S1 Br. S.S. Deerpool, J. W. Cameron, 2nd Officer,
0715 G.M.T.; 79° 05′ W; 12° 15′ N.

S2 Am. S.S. Beunaventura, H. Hollyer, 2nd Officer,
0719 G.M.T.; 76° 29′ W; 15° 25′ N.

S3 Am. S.S. Memphis City, H. C. Pritchard, 2nd Officer,
0720 G.M.T.; 79° 42′ W; 9° 46′ N.

The altitudes and azimuths of the beginning and end points from the ships were:

S1	from a 315°,	h . .°	to a 315°,	h 80°
S2	205	23	225±	5
S3	210	20	197	10

These observations were plotted here as usual and attempts made to find the most probable solution. The three azimuths agree well enough for the beginning point, but the two altitudes are seriously discordant. The altitudes agree excellently for the end point, but the azimuth from S2, on which ship it would appear that much the most careful notes were made, seems out about 6°. However, unless S1 gives a wholly wrong position for the ship, which other considerations make highly improbable, the 6±° correction to the azimuth from S2 must be made. A graphical solution then gives:

Sidereal time at end point	141°.2
Height beginning point	159 km
Height end point	56 km
Length of path	139 km
Radiant ..... h 48°, a 315°; R.A. 170°, Decl. —19°*	

*Measured approximately on globe.

Fully realizing that the only one of the above data with small probable error is the height of the end point, still it is well to deduce everything possible as to the drift of the train, for which drawings from S2 are available. According to this, the part of the path along which the train remained visible was from height 78 to 122 km. At first straight, a bend soon developed at 96 km height and the lower part of the path eventually bent to exactly right angles with the original direction of motion. This apparent upward component was evidently due to a lower local current moving towards azimuth 300°. Due to the semi-graphical method of reduction, a considerable error in the height of the beginning point and hence in the slope of the path, if the height of the end point is nearly correct, very fortunately does not make a proportional error in the heights given for the train. These latter can scarcely be too low, but are probably not much too high. The point at which the bend took place at 96 km shows the dividing line between two air currents at right angles: the lower moving towards 300° azimuth and lying between 78 and 96 km; the upper towards azimuth 210° and lying between 96 and 122 km. The velocities of the drifts cannot be determined from the data available. The train was described as follows:

S1— . . . While rising in the sky the meteor left behind it a broad stream of light and sparks, ranging in color from bright white or green immediately behind it, to orange or dull red at the horizon. This band slowly burnt out but was visible for nearly 3 minutes, and in the position where the meteor itself was extinguished, a white incandescent cloud was visible for over 7 minutes. An idea of the apparent size . . . may be gained when I say that the stream of light behind it was as broad as the Belt of Orion. (Note by C.P.O.: If one takes literally that the meteor *started from the horizon,* as the language might indicate, then no solution is possible except for the end point and to a lesser degree the heights of the train. As such a low altitude from S1 is utterly negatived by the observations from both the other ships, I have taken it to mean simply the meteor "rose" in the sky and the part *towards* the horizon had the colors indicated.)

S2— . . . The bright and clearly defined trail was visible for over 2 minutes as it slowly drifted toward Alpha Columbae and the bottom half gradually grew dimmer and broader as it slowly curved upward. The upper half kept its original direction and size. This curving process went on until the trail resembled a boomerang, with the bent part nearest the earth.

S3— . . . leaving a reddish colored tail which remained visible for 3 or 4 seconds longer. When the tail disappeared it seemed to leave a smokelike substance which remained visible 5 or 6 minutes.

Unfortunately S1 and S3 did not report any drift or changes, but these certainly took place and were excellently drawn by S2. The colors were reported as: bright greenish light, greenish yellow, and blue-white. If we average these a greenish color is indicated. The best description of its brightness comes from S2 as: ". . . a large extremely bright meteor . . . about the size of Venus but of such sharp brilliancy that its greenish-yellow light lit up the whole southern sky for 3 seconds . . ." S3 also gives a duration of 3 or 4 seconds. The average for S2 and S3 is hence 3¼ seconds, which indicates a geocentric velocity of 43 km/sec, which is rather low as the radiant was not far from the meteoric apex. However, the arbitrary, if apparently necessary, correction to the azimuth of end point for S2 tended to make the path shorter and velocity lower. The value 43 km/sec certainly may be considered a minimum velocity.

This is a good opportunity to discuss briefly why better results often are not obtained from observations made by trained navigators. First of all, each is

caught perforce by surprise, not expecting a fireball to appear. Secondly, I fear that most persons think an *approximate* statement of the coördinates of the meteor's beginning and end points is all that is necessary, and make no attempt to verify these by sextant or by plotting upon a star map. Thirdly, the position of the ship itself is probably not given with full accuracy. And lastly few will take the trouble to make, or perhaps do not understand the importance of, special observations on the long-enduring trains which are occasionally seen. Indeed, drawings with regard to the stars are necessary to interpret the complicated motions of these mysterious trains. However, more and more ships' officers are coöperating and the data become better and better year by year. It is but just to again express our grateful acknowledgment to the Hydrographic Office, U.S.N., and to the U.S. Weather Bureau, for without their cordial coöperation it would not be possible to make known to navigators the need and uses of such observations. In the last 15 years we have probably 2000 observations from ships at sea relative to fireballs, nearly all received through the coöperation mentioned, as well as a lesser number from land stations due, of course, to the Weather Bureau only. This constantly increasing mass of data has already been used in several researches and becomes more valuable year by year.

Flower Observatory, Upper Darby, Pennsylvania, 1939 March 6.

Psychological Errors in Meteor Work

By C. C. WYLIE

(First Paper)

As meteor work is primarily visual, and as the information on spectacular meteors must come almost entirely from the general public, the psychological errors affecting the reports are of great importance. The following are some which must be watched for with care.

Impression that a Bright Distant Meteor is Very Close

It is well known that when children see the moon coming up behind a tree, they believe the moon is just the other side of the tree. Adults have learned that the moon is farther away, but they rarely see spectacular meteors, so the psychological error operates for meteors. Intelligent adults then make the same error in estimating the distance of a bright meteor that the child does in estimating the distance of the moon.

When people see a spectacular meteor, perhaps 200 miles away in reality, go down the other side of a tree 100 feet away, it seems just the other side of that tree. Observers of such spectacular meteors falling at night often go out in the morning and hunt for the "star" which fell. If a stone, or some unusual object, is found, quite often it is picked up in the honest belief that it fell from heaven.

More than 90% of the newspaper items on the finding of meteorites turn out to be of this type. A spectacular meteor, really more than 50 miles away, has been seen, but it is thought to be not more than a few hundred yards away. A stone or other object is picked up as the "meteor," and this is announced in the local newspaper.

Fictitious Lengthening of Apparent Path

This effect is apparent when observations with a very limited field and in familiar surroundings are compared with open sky observations, especially in un-

familiar surroundings. Reports giving a length five or more times the correct are common.

The effect is very pronounced in reports from the general public on spectacular meteors, but it is evident also in plots of shooting stars. Inexperienced persons even though familiar with the constellations make their plots two or three times as long as an experienced person working nearby.

Fictitious Increase of Altitude

Probably this is the best known error. Astronomers are familiar with the fact that even one familiar with angles overestimates those near the horizon. Maunder once wrote that the general public reports anything over 45° altitude as "overhead." We have found this effect present, but to a smaller extent, in pointings made by observers. If the landmarks are not good, there is a tendency to point too high.

Apparent Direction of Travel Confused with Direction in which Meteor was Seen

A very comon report published in newspapers or received by letter is that the spectacular meteor passed over the community travelling in a certain direction. This report comes from towns more than 100 miles from the path of the meteor as often as from towns on the projected path. The apparent direction of travel of the meteor may vary more than 90° from the true direction. In fact, different individuals observing the same meteor from the same community may report directions varying more than 90°. It seems that, when the average person sees a spectacular meteor, he notices little except that the meteor seems close and that it seems to be going in a certain direction.

A great extension of the path of the meteor can be made by combining reports of this type received from communities near the extension of the real path of the meteor. For example, on the meteor of July 25, 1929, we received reports from Arkansas, south, to Wisconsin, north, all reporting in a general way that the meteor had passed over going from south to north. From these reports the average person would assume that the meteor started over northeastern Arkansas, passed across southeastern Missouri, and on over Illinois, going nearly over Chicago, and ended its career by plunging into Lake Michigan near Milwaukee. This fictitious path would have been more than ten times the real thing. A spectacular meteor is conspicuous at any distance up to that at which the curvature of the earth makes it invisible. This is approximately 500 miles, and so by combining reports of this type, a fictitious length of about 1000 miles is possible for a meteor whose real path is little more than 100 miles in length.

Two or More Meteors Treated as One

Frequently when letters are sent to the newspapers requesting reports on a certain bright meteor, reports on two or more meteors, instead of one, are received. For example, in November, 1929, a spectacular meteor, which left a 20-minute trail, fell in western Missouri a little south of Kansas City. This meteor was observed in Iowa, but most of the reports came from Kansas, Missouri, and Arkansas. On calculating the path, we found that the reports referred to two meteors, the one which fell a little south of Kansas City, and another which fell in northeastern Arkansas. If an approximate path had been obtained by noting the towns the meteor had "passed over," a very long fictitious path would have been obtained.

Hearing a Light

When a spectacular meteor comes low, detonations may be heard. Like the

thunder following lightning, these sounds are heard a considerable time after the light is seen. But many observers have reported a "swish" heard simultaneously with the appearance of the meteor.

This sound is heard just as frequently at distances of 200 miles as from within a few miles of the path. For many of these observers reporting the sound simultaneously, a real sound could not be heard for more than ten minutes. No known physical effect can account for such a swish.

In deciding whether this effect is psychological, the following facts are pertinent. First, a considerable number of the reports on bright meteors come from persons with an elementary knowledge of astronomy, sufficient to know that the meteor is probably fifty or more miles away. None of these persons report hearing a sound. Many see the meteor from quiet surroundings and report that the fall of the meteor was accompanied by no sound.

Second, the swish is reported occasionally by intelligent people who, however, are less familiar with the elementary facts of astronomy. These persons think of the bright meteor as being only a few hundred feet away, so close that a sound would be expected. If such a person is interviewed within a few days of the fall of the meteor, he recalls that there were other noises, insects, the wind blowing through the trees, or the sound of an automobile. When interviewed within a few days of the fall of the meteor, we never have found such a person reasonably sure that he heard any sound from the meteor. Incidentally, the story of the meteor given to the expert is noticeably less positive than the account given to friends. The difference was surprising to us at first.

In accounts of meteors which fell years ago, we do find positive statements that such a sound was heard. Evidently in retelling the story to friends, the account has been fixed without the qualifying circumstances, and the person becomes absolutely certain that such a sound came from the meteor. However, such recollections include other astronomical marvels, just as often as the story of this sound. We hear of shooting stars that knocked fixed stars out of the sky, and of meteors that fall between the observer and a building, so that the bright meteor was seen projected against the building. We hear of seeing stars by daylight from the bottom of a well and of other things that happen only in the imagination.

Seeing an Echo

When detonations are heard following the fall of a spectacular meteor, the first sound is an explosion, usually coming from the direction of the point where the meteor was seen to disappear. This is followed by a roar rolling back along the apparent path of the meteor. As was explained in an earlier paper, this roar rolling back along the path is in reality an echo. However, people tell us that they have seen something going across the sky along with this roar. In other words, these persons imagined that they could see the echo. This frequently causes difficulty in judging the real direction of travel of a spectacular meteor which dropped meteorites. A considerable number of people will report that the meteor was travelling in the reverse of the true direction.

Mirror Vision

Due to a lack of cerebral dominance, many intelligent children have difficulty with a mirroring of what they see. The letter "b" is confused with "d," and 12 is confused with 21, 28 with 82, etc. On every bright meteor for which we receive a considerable number of reports, some give the path "mirrored," with the direction of travel reversed. Evidently, many adults are not entirely free from this difficulty.

MINIMIZING THE EFFECT OF THESE ERRORS

Observers of spectacular meteors should be interviewed by persons familiar with these errors. The interviews should be made as soon as possible after the fall of the meteor, with the observer exactly where he was when the meteor fell. If possible, use only observers who were sitting or standing in familiar surroundings, and with the path fixed by good landmarks. In the apparent path as pointed out by such an observer, the psychological errors are kept at a minimum.

University of Iowa, February 15, 1939.

Contributions of the Society for Research on Meteorites

Edited by FREDERICK C. LEONARD,
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Second Catalog of Meteoritic Falls Reported to the Society for Research on Meteorites: August, 1936, to December, 1938*

By ADDIE D. NININGER,
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Chairman of the Committee on Catalog of the S.R.M.

Abstract.—A list of 82 new discoveries (S.R.M. provisional nos. 101-182) has been added to the catalog of the known meteoritic falls of the world since August, 1936. (See ref. no. 1, *post.*) Outstanding features of this list are 5 authentic reports of houses which have been struck by falling meteorites. The discovery of a new meteoritic crater has been made, and a meteorite was found while a hole was being dug for a post. It is pointed out that the major portion of these new discoveries has resulted from the systematic search which is being carried on in the Great Plains region of the United States by and under the direction of the American Meteorite Laboratory of Denver, Colorado.

In the list of meteoritic falls which follows, 23 entries relate to discoveries which antedate our previous report,[1] but which either were overlooked or had not been reported at that time. The Society for Research on Meteorites will publish lists of discoveries regularly, as one of its major contributions to research on meteorites, and all workers everywhere are urged to report all falls and "finds" promptly, with complete data as to the time, place, classification, weight, *etc.*, of each specimen, as accurately as possible. Dr. F. C. Leonard has recently recommended that all discoveries be located in terms of their latitude and longitude.[2] We have not always included these data in our records, but we heartily approve of the practice, and urge that at least degrees and minutes of latitude and longitude be included, in future, in every report.

Summarizing the accompanying list, we have a total of 82 distinct falls repre-

*Read at the Sixth Annual Meeting, Richmond, Virginia, December, 1938.

sented. 15 were witnessed and 67 were unwitnessed. Of the witnessed falls, all were stones but one, which was a mesosiderite. 19 of the unwitnessed falls discovered were irons, while one was a pallasite and one was a mesosiderite. The number of discoveries recorded in this list for the states of Texas, Kansas, Colorado, and Nebraska, throws an interesting light on the important part played in recent years by an active field search for meteorites. In Farrington's *Catalogue of the Meteorites of North America to January 1, 1909*,[3] Texas is credited with 15 falls, Kansas with 15, Colorado with 4, and Nebraska with 6. These figures represent the total number of discoveries recorded for these states up to the date of January 1, 1909. There was very little change in these figures in the next 14 years, *i.e.*, up to 1923. At the present time, the record for these states stands as follows: Texas, 64; Colorado, 33; Kansas, 44; and Nebraska, 23. It will be noted that, in these 4 states, the number of discoveries recorded in our present list almost equals the total number recorded by Farrington!

Most interesting is the fact that within the short period covered by this report, there have been received accounts of 5 meteorite falls' striking houses, though not all of them fell in the course of this period; in fact, 3 of the 5 fell prior to the beginning date of our list, in 1936. The Baxter, Missouri, meteorite fell on January 18, 1916, at 9:00 A.M., crashed through a house-roof, and was promptly collected from the attic, but was never reported to the scientific world until December, 1937.[4] The Kurumi, Japan, meteorite fell upon and ricocheted from the roof of a house on May 27, 1930. The Lubimowka stone penetrated a roof in Ukraine on April 12, 1936. The Pantar fall in the Philippine Islands is said to have showered a number of houses with small stones.[5] The Benld, Illinois, meteorite penetrated the roof of a garage and the top and cushion of the inclosed automobile, on September 29, 1938.[6] Strangely enough, 4 of these house bombardments took place in forenoon hours, at times of the day when falls have been notably scarce.

Our list brings to light the case of the Goodland, Kansas, meteorite, which was found at the bottom of a post-hole which was being dug for a corner post. The Miami, Texas, meteorite was plowed out, but its value was unappreciated; later, it was buried in the process of fence construction, and remained buried for 6 years, at the end of which time it was dug out by members of the American Meteorite Laboratory. The Monahans, Texas, meteorite furnishes another of those rare instances of meteorites' being found under ground, yet not by the aid of the plow. A rusty-colored spot was noticed on the sand. Upon inspection, it was found that the color was due to flakes of heavy rust scale. A 61½-pound iron meteorite was found at a depth of one foot.

The American Meteorite Laboratory acknowledges the valued services of Mr. Alex Richards and Mr. Frank Clay Cross as aids in the educational program which has made possible many of the discoveries which have been made and reported by that Laboratory. Other individuals who have aided materially in supplying the data for this list are Mr. O. E. Monnig, Mr. Fletcher Watson, Jr., Mr. Ben Hur Wilson, Dr. L. J. Spencer, Mr. A. M. Brooking, and Mr. R. Bedford. We wish to express our special appreciation of the coöperation received from the United States National Museum, the Bureau of Economic Geology of the University of Texas, the Geological Survey of Oklahoma, the Texas Technological College, and the Colorado School of Mines. Other institutions and individuals have contributed to our lists in the past, and we hope that they will continue to do so as opportunity offers in the future.

SECOND CATALOG OF METEORITIC FALLS REPORTED TO THE SOCIETY FOR RESEARCH ON METEORITES: AUGUST, 1936, TO DECEMBER, 1938

[*The falls following are listed alphabetically and are numbered provisionally in continuation of those contained in the first S. R. M. catalog, loc. cit., ref. no. 1, post.*]

101. Alamogordo, Otero Co., New Mexico. Lat. 32° 26′ N., long. 105° 44′ W. Stone. Found 1938. Wt. 13.6 kg. (30 lb.). Many fragments. Reported by L. J. Daugherty to Am. Met. Lab.
102. Alamosa, Alamosa Co., Colorado. Lat. 37° 32′ N., long. 105° 44′ W. Stone. Found 1937. Wt. 1.8 kg. (4 lb.). One stone. Reported by Alexis McKinney to Am. Met. Lab.
103. Allen, Collin Co., Texas. Stone. Found about 1923. Recog. 1938. Wt. 1.4 kg. (3 lb.). One stone. Reported by O. E. Monnig.
104. Altonah, Duchesne Co., Utah, near shore of Moon Lake. Iron. Recog. 1932. Wt. 21 kg. (46.2 lb.). One mass. Reported by Lloyd Stewart to Am. Met. Lab.
105. Arcadia, Valley Co., Nebraska. N. W. ¼ Sec. 11, Twp. 18, R. 16. Stone. Recog. 1937. Wt. 19.4 kg. (43 lb.). One stone. Reported by Joe Hruby to Am. Met. Lab.
106. Atlanta, Winn Co., Louisiana. S. E. ¼ Sec. 14, Twp. 9 N., R. 4 W. Stone. Found 1938. Wt. 5.5 kg. (12 lb.). One fragment. Reported by W. H. Worsham to Am. Met. Lab.
107. Aurora, Colfax Co., New Mexico. Lat. 36° 20′ N., long. 105° 3′ W. Stone. Found 1938. Wt. 1 kg. (2.2 lb.). One stone. Reported by Gardien Tarplay to Am. Met. Lab.
108. Bartlet, Williamson Co., or Bell Co., Texas. Iron. Recog. 1938. Wt. 8.59 kg. (18.94 lb.). Reported by V. E. Barnes, Univ. of Texas. One mass.
109. Baxter, Stone Co., Missouri. Stone. Fell 1916 Jan. 18, 9:00 A.M. Wt. 611 g. One stone. Reported by J. W. Jackson to Am. Met. Lab.
110. Beenham, Union Co., New Mexico. Twp. 25, R. 30 E. Stone. Found 1937. Wt. 44 kg. (97 lb.). Many broken individuals and fragments. Reported by Luis Garcia to Am. Met. Lab.
111. Benld, Macoupin Co., Illinois. S. W. ¼ Sec. 31, Twp. 8 N., R. 6 W. Stone. Fell 1938 Sep. 29, about 9:00 A.M. Wt. 1770.5 g. One stone. Reported by Ben Hur Wilson.
112. Bolivia, South America. Iron. Found 1927. Wt. 21.25 kg. (47.8 lb.). One mass. Reported by U. S. Nat. Mus.
113. Box Hole, Central Australia. Iron. Found 1937. Wt., several hundred lb., of fragments and iron shale. Reported by R. Bedford.
114. Brady, McCulloch Co., Texas. 9 miles S. W. of Brady. Stone. Found 1937. Wt. 927 g. One stone. Reported by Dave Rains to Am. Met. Lab.
115. Bristol, Sullivan Co., Tennessee, about 12 miles S. E. of Bristol. Iron. Found 1937. Wt. 20 kg. (44 lb.). One mass. Reported by C. J. Stone to Am. Met. Lab.
116. Broken Bow, Custer Co., Nebraska, 9 miles S. and 3 miles W. of Broken Bow. Stone. Found 1937. Wt. 6.7 kg. (15 lb.). One stone. Reported by Mrs. C. C. Huff to Am. Met. Lab.

[182. Chicora, Butler Co., Pennsylvania: see no. 182 at end of list.]

117. Clark Co., Kentucky. Iron. Reported in 1937. Wt. 11.3 kg. (25 lb.). One mass. Reported by J. D. Figgins to Am. Met. Lab.
118. Coolidge, Hamilton Co., Kansas. Lat. 36° 47′ N., long. 102° W. Stone. Found 1937. Wt. 4.5 kg. (10 lb.). One stone. Reported by Myral Davis to Am. Met. Lab.
119. Cope, Washington Co., Colorado. Secs. 35 and 36, Twp. 5, R. 49. Stone. Found 1934. Recog. 1937. Wt. 12 kg. (26 lb.). 11 stones. Reported by Allen Cecil and F. B. Cecil to Am. Met. Lab.
120. Coya Norte, Chuquicamata, Chile. Iron. Found about 1928. Wt. 17.9 kg. (39.38 lb.). One mass. Reported by U. S. Nat. Mus.
121. Dexter, Cooke Co., Texas. Iron. Found 1889. Wt. 1.7 kg. (3.8 lb.). One mass. Reported by Am. Mus. Nat. Hist.

122. Dix, Kimball Co., Nebraska. N. W. ¼ Sec. 36, Twp. 13, R. 54. Stone. Found 1938. Wt. 44 kg. (97 lb.). 3 fragments. Reported by Jerry Todd to Am. Met. Lab.
123. Douar Mghila, French Morocco, N. Africa. Lat. 32° 3′ N., long. 6° 3′ W. Stone. Fell 1932 Aug. 22, 3:00 P.M. Shower of some 40 stones, 2 of which, weighing 1,161 g., recovered. Reported by L. J. Spencer.
124. Elton, Dickens Co., Texas. Recog. 1938. Iron. Wt. 1.9 kg. (4.35 lb.). One mass. Reported by V. E. Barnes, Univ. of Texas.
125. Enon, Clark Co., Ohio, 3 miles S. W. of Enon. Mesosiderite. Found about 1883. Recog. 1938. Wt. 763 g. One mass. Reported by U. G. Drummond to Am. Met. Lab.
126. Farnum, Nebraska (either Lincoln or Frontier Co.). Stone. Found 1937. Wt. 4.2 kg. (9.2 lb.). One stone. Reported by Miss Mary Jane Heath to Am. Met. Lab.
127. Floydada, Floyd Co., Texas. S. W. ¼ Sec. 8, Blk. D. 5. Iron. Known before 1912. Recog. 1938. Wt. 12.5 kg. (27.5 lb.). One mass. Reported by E. H. Howard, Univ. of Pennsylvania.
128. Garnet, Anderson Co., Kansas. Stone. Recog. 1938. Wt. 4.7 kg. (10.3 lb.). One stone. Reported by P. A. Hardesty to Am. Met. Lab.
129. Goodland, Sherman Co., Kansas. S. E. ¼ Sec. 1, Twp. 10, R. 41. Stone. Found 1923. Recog. 1938. Wt. 3.6 kg. (7.9 lb.). 2 fragments which fit together. Reported by Carl S. Moore to Am. Met. Lab.
130. Grant Co., Kansas. Lat. 37° 28′ N., long. 101° 26′ W. N. W. ¼ Sec. 1, Twp. 30, R. 38. Stone. Found 1936. Wt. 2.3 kg. (5 lb.). Several fragments. Reported by Ralph Keply to Am. Met. Lab.
131. Hardwick, Battle Plain Twp., Rock Co., Minnesota. Found 1937. Stone. Wt. 7.8 kg. (17.25 lb.). One stone. Reported by Mrs. John Honken, Jr., to Am. Met. Lab.
132. Haviland, Kiowa Co., Kansas. N. E. ¼ Sec. 27, Twp. 28, R. 17 W. Stone. Found 1937. Wt. 1035 g. One stone. Reported by Budd Evans to Am. Met. Lab.
133. Hildreth, Franklin Co., Nebraska. N. W. ¼ Sec. 17, Twp. 5, R. 46. Stone. Found 1894. Recog. 1937. Wt. 3.06 kg. (6.7 lb.). One mass. Reported by Arch Josh to Am. Met. Lab.
134. Hoba, Southwest Africa. Lat. 19° 35′ S., long. 17° 56′ E. Iron. Discovered probably in 1920. Wt. estimated at 60 tons. Reported by Brit. Mus. Nat. Hist.
135. Holly, Prowers Co., Colorado. Twp. 26, R. 42 W. Stone. Found 1937. Wt. 299 g. 2 stones. Reported by Myral Davis to Am. Met. Lab.
136. Ingalls, Gray Co., Kansas. S. W. ¼ Sec. 22, Twp. 26, R. 29. Stone. Found 1937. Wt. 226 g. One fragment. Reported by Clyde Muntz to Am. Met. Lab.
137. Johnson, Stanton Co., Kansas. N. E. ¼ Sec. 27 and N. W. ¼ Sec. 27, Twp. 29, R. 40. Stone. Found 1937. Wt. 10.4 kg. (22.8 lb.). 2 stones. Reported by Oscar Shepard to Am. Met. Lab.
138. Junction, Kimble Co., Texas. Stone. Found 1932. Recog. 1938. Wt. 241 g. Fragment. Reported by O. E. Monnig.
139. Kaalijärv, Oesel, Estonia. Iron. Found 1937. Wt. 100 g. 30 small fragments of rusted meteoritic iron recovered from a crater. Reported by I. Reinvald.
140. Kurumi, Kurumi, Miki, N. W. of Kobe, Japan. Stone. Fell 1930 May 27, about noon. Wt. 46 g. 2 broken fragments. Reported by Fletcher Watson, Jr.
141. Ladder Creek, Greeley Co., Kansas. S. W. ¼ Sec. 32, Twp. 16, R. 39. Stone. Found 1937. Wt. 35.1 kg. (77.2 lb.). Many fragments. Reported by Edgar Linn to Am. Met. Lab.
142. Lafayette, Tippecanoe Co., Indiana. Stone. Recognized 1931. Wt. 600 g. Reported by Purdue University.
143. Lawrence, Douglas Co., Kansas. Stone. Known 1928. Wt. 515 g. One stone. Reported by U. S. Nat. Mus.
144. Lowicz, Warsaw, Poland. Lat. 52° 6′ N., long. 19° 57′ E. Mesosiderite. Fell 1935 Mar. 12, 12:52 A.M. Wt. 59 kg. (129.8 lb.). 58 stones. Reported by L. J. Spencer.

145. Lubimowka, Mikhailov Dist., Ukraine. Stone. Fell 1936 Apr. 12, 1:00 A.M. One stone of 509 g. and several fragments, one of which weighed 51.49 g., recovered. Reported by L. J. Spencer.
146. Miami, Roberts Co., Texas. Stone. Found 1937. Wt. 57 kg. (127 lb.). One stone. Reported by Judge A. Mead to Am. Met. Lab.
147. Monahans, Ward Co., Texas. 7 miles S. and 1 mile E. of Monahans. Iron. Found 1938. Wt. 27.9 kg. (61.5 lb.). One mass. Reported by M. P. White to Am. Met. Lab.
148. Morven, South Canterbury, New Zealand. Stone. Found 1925. Wt. 6.75 kg. (14.8 lb.). One stone recovered. Reported by Fletcher Watson, Jr.
149. Nashville, Kingman Co., Kansas. Stone. Undescribed. Reported by W. H. Hooker to Am. Met. Lab.
150. Nazareth, Castro Co., Texas. Stone. Found 1938. Wt. 44 g. One stone. Reported by O. E. Monnig.
151. Ness Co., Kansas, No. 2, 1938. Stone. Recog. 1938. Wt. 652 g. One stone. Reported by Am. Met. Lab. Distinct from the Ness Co., No. 1, find of 1897.
152. Pantar, Lanao, Philippine Islands. Stone. Fell 1938 June 16, forenoon. Wt. 2.32 kg. (5.1 lb.) recovered. One stone and a small fragment. Reported by F. M. VanTuyl to Am. Met. Lab.
153. Peetz, Logan Co., Colorado. N. W. ¼ Sec. 30, Twp. 12, R. 50 W. Stone. Found 1937. Wt. 11.5 kg. (25.25 lb.). One stone. Reported by Earl Hecker to Am. Met. Lab.
154. Phulmari, Hyderabad, India. Stone. Fell before 1936. Wt. 4064 g. One stone. Reported by Mohd. A. R. Khan.
155. Phum Sambo, Kompong Cham, Cambodia, Indo-China. Stone. Fell 1933 Jan. 9, 4:00 P.M. Wt. 7.8 kg. (17 lb.). One stone. Reported by L. J. Spencer.
156. Pine Bluff, Laramie Co., Wyoming. Sec. 24, Twp. 14, R. 61. Stone. Found 1935. Recog. 1938. Wt. 2.7 kg. (6 lb.). One stone. Reported by Ralph H. McFarland to Am. Met. Lab.
157. Pontlyfni, England. Lat. 53° N., long. 4° 3′ W. Stone. Fell 1931 Apr. 14, 11:53 A.M. Wt. 5 oz. recovered. Reported by Fletcher Watson, Jr.
158. Prambachkirchen, Northern Austria. Lat. 48° 3′ N., long. 14° E. Stone. Fell 1932 Nov. 5, 9:55 P.M. Wt. 2125 g. One stone. Reported by Fletcher Watson, Jr.
159. Puripica, Antofagasta, Chile. Iron. Recog. 1929. Wt. 19 kg. (41.8 lb.). One mass. Reported by U. S. Nat. Mus.
160. Ransom, Trego Co., Kansas. N. W. ¼ Sec. 25, Twp. 15, R. 24. Stone. Recog. 1938. Wt. 15 kg. (33 lb.). 4 stones. Reported by Fred Plath to Am. Met. Lab.
161. Rush Creek, Kiowa Co., Colorado. Sec. 1, Twp. 17, R. 47 W. Stone. Found 1938. Wt. 9.3 kg. (20.5 lb.). 3 fragments. Reported by Leland Reinecker to Am. Met. Lab.
162. Sanchez Estate, Coahuila, Mexico. Iron. Found 1854. Wt. 114.3 kg. (251.46 lb.). One mass. (H. H. Nininger regards this as distinct from Coahuila.)
163. Sazovice, Zlín, Czechoslovakia. Lat. 49° 14′ N., long. 17° 34′ E. Stone. Fell 1934 June 28, 8:00 P.M. Wt. 411.98 g. One stone. Reported by L. J. Spencer.
164. Schertz, Guadalupe Co., Texas. Iron. Wt. 308 g. One mass. Reported by V. E. Barnes, Univ. of Texas.
165. Soper, Choctaw Co., Oklahoma. Sec. 3, Twp. 6 S., R. 16 E. Iron. Recog. 1938. Wt. 3.7 kg. (8.14 lb.). One mass. Reported by F. C. Wood, Oklahoma Geol. Survey.
166. St. Ann, Nebraska. Stone. Found 1938. Wt. 373.5 g. One stone. Reported by E. P. Zimmer to Am. Met. Lab.
167. St. Mary's, St. Mary's Co., Maryland. Stone. Fell 1919 June 20, about 6:00 P.M. Wt. 24.25 g. Fragment. Reported by L. Bryant Mather, Jr.
168. Sterling, Douglas Co., Colorado. Pallasite. Found about 1900. Wt. 679.5 g. Fragment. Reported by Charles Skeele Palmer to Am. Met. Lab.
169. Smith Center, Smith Co., Kansas. S. E. ¼ Sec. 20, Twp. 3, R. 15. Stone. Found 1937. Wt. 1585 g. One stone. Reported by W. E. Lee to Am. Met. Lab.

170. Smith Co., Kansas. N. E. ¼ Sec. 26, Twp. 4, R. 15. Stone. Found 1937. Wt. 4.5 kg. (9.9 lb.). One stone. Reported by W. E. Lee to Am. Met. Lab.
171. Tatum, Lea Co., New Mexico. Stone. Found 1938. Wt. 1.8 kg. (3 lb., 15 oz.). One stone. Reported by O. E. Monnig.
172. Tenham, Queensland, Australia. Lat. 25° 44′ S., long. 142° 57′ E. Stone. Fell 1879 Mar. or Apr. Wt. 51.6 kg. (113.5 lb.). 104 stones. Reported by L. J. Spencer.
173. Texline, Dallam Co., Texas. Stone. Found 1937. Wt. 26.2 kg. (57.6 lb.). 4 individuals. Reported by Floyd V. Studer to Am. Met. Lab.
174. Uvalde, Uvalde Co., Texas. Stone. Found about 1915. Recog. 1938. Wt. 7.5 kg. (17.5 lb.). One mass and fragments. Reported by O. E. Monnig.
175. Vigo Park, Briscoe Co., Texas. Stone. Found 1934. Recog. 1938. Wt. 35 g. Fragment. Reported by O. E. Monnig.
176. Wabar, South Arabia. Lat. 21° 5′ N., long. 50° 7′ E. Iron. Found 1932 Feb. Wt. 11.5 kg. (25.3 lb.). 7 pieces found near the crater there. Reported by L. J. Spencer.
177. Waldo, Osborne Co., Kansas. Stone. Found 1937. Wt. 1.3 kg. (2.9 lb.). One stone. Reported by Am. Met. Lab.
178. Whittman, Cherry Co., Nebraska. Stone. Found 1937. Wt. 221 g. One stone. Reported by A. T. Hill to Am. Met. Lab.
179. Wiley, Prowers Co., Colorado. 4½ miles N. W. of Wiley. Iron. Found 1938. Wt. 3.5 kg. (7.7 lb.). One mass. Reported by John A. Berry to Am. Met. Lab.
180. Woods Mountain, McDowell Co., North Carolina. Iron. Found, date unknown. Wt. 3017 g. One mass. Reported by S. H. Perry.
181. Wray, Yuma Co., Colorado. S. W. ¼ Sec. 35. Stone. Found 1936. Recog. 1938. Wt. 281.7 g. One stone. Reported by Harold Morreau to Am. Met. Lab.
182. Chicora, Butler Co., Pennsylvania. Stone. Fell 1938 June 24, 6:00 P.M. Wt. not reported. 2 stones. Reported by U. S. Nat. Mus.

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[2] F. C. Leonard: "Recording the Time and Place of Fall and the Designation of Meteorites," *C.S.R.M.: P. A.*, **46**, 581-2; **2**, No. 1, 64, 1938.
[3] *Mem. Nat. Acad. Sci.*, **13**, 513 pp., 36 pls., 1915.
[4] *C.S.R.M.: P. A.*, **46**, 407-9; **2**, No. 1, 53-5, 1938.
[5] *C.S.R.M.: P. A.*, **46**, 578-80; **2**, No. 1, 61-3, 1938.
[6] *P. A.*, **46**, 548-58, 1938.

Members Elected as Fellows of the Society on February 21, 1939

In accordance with Art. 2, Sec. 2, of the *Constitution*, and Art. 1, Secs. 2 and 3, of the *By-Laws*, the following members, on nomination by the Ex-President and the Secretary, were elected, under date of February 21, 1939, by the Council, as fellows of the Society. Art. 1, Sec. 2, of the *Constitution* reads in part as follows:

"Any member who is an active professional worker in meteoritics, astronomy, geology, or some cognate science, or who has advanced any of these sciences by research, may be elected by the Council to fellowship in the Society. The members of the first Council shall constitute the original fellows of the Society . . ."

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Boon, Professor John D., Dep. of Physics, Southern Methodist University, Dallas, Tex.
Buddhue, Mr. John Davis, 99 S. Raymond Av., Pasadena, Calif.
Cleminshaw, Dr. C. H., Griffith Observatory and Planetarium, Los Angeles, Calif.
Evans, Dr. Robley D., Dep. of Physics, Massachusetts Institute of Technology, Cambridge, Mass.
Fath, Dr. Edward A., Goodsell Observatory, Carleton College, Northfield, Minn.

Fenner, Dr. Charles, Dep. of Education, University of Adelaide, Adelaide, *South Australia*
Fisher, Dr. Clyde, Dep. of Astronomy (Hayden Planetarium), American Museum of Natural History, New York, N. Y.
Gianella, Dr. Vincent P., Dep. of Geology, University of Nevada, Reno, Nev.
Goldschmidt, Dr. V. M., Geologisk Museum, Trondhjemsveien 23, Oslo, *Norway*
Haynes, Dr. E. S., Dep. of Astronomy, University of Missouri, Columbia, Mo.
Heineman, Dr. Robert E. S., Arizona Bureau of Mines, University of Arizona, Tucson, Ariz.
Hunt, Dr. Walter F., Dep. of Mineralogy, University of Michigan, Ann Arbor, Mich.
Kaplan, Dr. Joseph, Deps. of Physics and Astronomy, University of California, Los Angeles, Calif.
Kašpar, Dr. Jan, Narodni Museum, Prague II, *Czechoslovakia*
Khan, Professor Mohd. A. R., Begumpet, Deccan, N.S.R., *India*
King, Dr. Arthur S., Mt. Wilson Observatory, Pasadena, Calif.
Kulik, Professor Leonidas A., Commission on Meteorites, Academy of Sciences of the U.S.S.R., Moscow A, Staromstny 35, *U.S.S.R.*
La Paz, Dr. Lincoln, Dep. of Mathematics, Ohio State University, Columbus, Ohio
Linsley, Professor Earle G., Chabot Observatory and Mills College, Oakland, Calif.
Lipman, Dr. Charles B., Dean, Graduate Division, University of California, Berkeley, Calif.
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Mather, Dr. Kirtley F., Dep. of Geology, Harvard University, Cambridge, Mass.
Meyerhoff, Dr. Howard A., Dep. of Geology, Smith College, Northampton, Mass.
Monnig, Mr. Oscar E., 312 W. Leuda St., Fort Worth, Tex.
Müllerried, Dr. F. K. G., 11a Cordoba 197, Mexico, D. F., *Mexico*
Nininger, Mrs. Addie D., American Meteorite Laboratory, Denver, Colo.
Ogilvie, Dr. (Miss) Ida H., Dep. of Geology, Barnard College, Columbia University, New York, N. Y.
Olivier, Dr. Charles P., Flower Observatory, University of Pennsylvania, Upper Darby, Pa.
Palache, Dr. Charles, Dep. of Mineralogy, Harvard University, Cambridge, Mass.
Paneth, Dr. F. A., Dep. of Chemistry, University of Durham, Durham, *England*
Perry, Mr. Stuart H., Editor, *The Adrian Daily Telegram*, Adrian, Mich.
Prouty, Dr. William F., Dep. of Geology, University of North Carolina, Chapel Hill, N. C.
Pruett, Professor J. Hugh, General Extension Division, University of Oregon, Eugene, Ore.
Schaller, Dr. Waldemar T., Div. of Chemical and Physical Research, U. S. Geological Survey, Washington, D. C.
Smith, Professor Edward S. C., Dep. of Geology, Union University, Schenectady, N. Y.
Spencer, Dr. L. J., 111 Albert Bridge Rd., London, S. W. 11, *England*
Thiesmeyer, Dr. Lincoln R., Dep. of Geology, Lawrence College, Appleton, Wis.
Van Tuyl, Dr. Francis M., Dep. of Geology and Mineralogy, Colorado School of Mines, Golden, Colo.
Winchell, Dr. A. N., Dep. of Geology, University of Wisconsin, Madison, Wis.
Young, Dr. David M., Dep. of Geology, University of Kentucky, Lexington, Ky.

ROBERT W. WEBB, *Secretary*

Comet Notes

By G. VAN BIESBROECK

COMET 1939 *a* (KOSIK-PELTIER) has rapidly moved out of sight for northern observers at the end of February. After perihelion on February 6 it continued to gain in brightness in spite of its increasing distance. The greatest intensity which was expected about February 10, did not occur until February 22 when the writer estimated the total intensity as $5^{M}.4$. By February 27 it had dropped to $6^{M}.1$, after

which the moon made estimations difficult at low altitude. The object is probably still easily observable in the southern hemisphere.

Several improved orbits have been computed but they differ immaterially from the elements given previously.

No other known comets are visible at this time. But before long we can expect the recovery of PERIODIC COMET PONS-WINNECKE for which the search ephemeris was given on p. 164.

Fort Davis, Texas, 1939 March 14.

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

Period-Frequency of Cepheid Variables: Continuing our discussion of Schneller's 1939 Catalogue of Variables, we find that a fairly accurate idea of the relative period-frequency of Cepheids can be obtained from the table in which he lists variable stars having periods of less than 100 days, exclusive of eclipsing systems. One thousand one hundred and thirteen Cepheids are included, 285 of which have periods greater than 1.0 day.

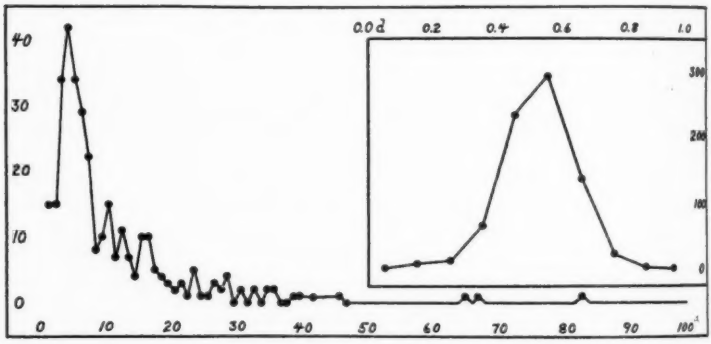

FIGURE 1
FREQUENCY OF CEPHEID VARIABLES

By far the largest number of Cepheids (790) are those having periods of less than a day, with a maximum frequency between 0.5 and 0.6 day. Prager originally referred to them as of RR Lyrae type—Bailey's cluster type. The shortest period found was for CY Aquarii, $1^h\,28^m$; V Puppis was next, with a period of $1^h\,40^m$. Relatively few RR Lyrae stars have been found to possess periods of less than 0.3 day or greater than 0.8 day, and there is a rapid falling off in frequency after 0.6 day.

When one considers the Cepheids that have periods greater than 1.0 day, a maximum frequency is found to occur between 4 and 5 days, with a steep rise from 3.0 days, and a slightly less rapid but progressive falling off from 5 to 10 days.

Slight rises in freqency occur at 10, 12, and 16 days, but they are not so marked as had been thought from earlier discussions. A smooth curve could well be drawn through the frequency points without showing large deviations.

The longest-period genuine Cepheid appears to be DN Arae, discovered and discussed by Miss Swope, which has a period of 82 days. (In the following notes Dr. C. P. Gaposchkin calls attention to the possibility that UW Librae, with a period of 85 days, is the longest-period Cepheid.) Few Cepheids—only six—have periods greater than 40 days, and for some of these stars a certain amount of doubt exists as to their classification as Cepheids.

Plots of the frequency of Cepheids having periods less than, and greater than, 1.0 day are shown in Figure 1. Between variables with periods of 40 and 100

TABLE I

Period	RR Lyrae	δ Cephei	ζ Geminorum	All Cepheids	RV Tauri	Semi-regular	?-Mira	Total	% Cepheid	Period	RR Lyrae	δ Cephei	ζ Geminorum	All Cepheids	RV Tauri	Semi-regular	?-Mira	Total	% Cepheid
0	790		1	791			9	800		52							1	1	
1	3	10	2	15			2	17	4	55					1			1	
2		12	3	15				15	5	56					1		1	2	
3		30	4	34			1	35	12	57					1			1	
4		41	1	42			1	43	15	61					1			1	
5		33	1	34				34	12	63					1		1	2	
6		29		29				29	10	64		1		1	3			4	0.4
7		22		22				22	8	65					1			1	
8		8		8				8	3	66		1		1	1			2	0.4
9		4	6	10				10	4	67					1		2	3	
10		5	10	15				15	5	68							1	1	
11		6	1	7			1	8	2	69					1		1	2	
12		10	1	11				11	4	70					1		3	4	
13		6	1	7				7	2	72							1	1	
14		4		4				4	1	73							1	1	
15		10		10			1	11	4	75					3			3	
16		7	3	10				10	4	76						1		1	
17		5		5			1	6	2	77					2		1	3	
18		4		4				4	1	78					2		1	3	
19		2	1	3			1	4	1	79							2	2	
20		2		2				2	1	80					1		1	2	
21		3		3				3	1	81					1		2	3	
22		1		1			1	2	1	82		1		1				1	0.4
23		5		5			1	6	2	83					1	1	1	3	
24		1		1				1	0.4	85							2	2	
25		1		1				1	0.4	86					1			1	
26		3		3				3	1	87					3			3	
27		2		2				2	1	88					1		5	6	
28		4		4				4	1	89					1			1	
30		2		2				2	1	90					1		2	3	
32		2		2				2	1	91						1	1	2	
34		2		2	1	1		4	1	92					1			1	
35		2		2				2	1	93							1	1	
38		1		1				1	0.4	94							1	1	
39		1		1				1	0.4	95							2	2	
41		1		1				1	0.4	96						1		1	
42							1	1		97							3	3	
45		1		1				1	0.4	98					1			1	
46					1			1		99							2	2	
51					1			1											
										Totals	793	285	35	1113	35	5	59	1212	

days lie many variables of peculiar type—enigmatic stars which are neither Cepheid nor long-period variables. They have frequently been referred to as semi-regular and RV Tauri stars; actually there appears to be little distinction between these two classes. They vary, in general, continuously in brightness, with an apparent alternation of deep and shallow minima; but at times the alternation is entirely lacking or reversed. This type of variation is found in many other stars with periods even greater than 100 days. The best known examples are: R Scuti, period 145 days; R Sagittae, period 70 days; and AC Herculis, period 75 days.

Schneller lists five variables of the "Mira-type" (long-period) with periods less than 100 days, namely: RU Camelopardalis, 22 days; RU Velorum, 63 days; TZ Cephei, 83 days; T Centauri, 90 days; and RT Cancri, 94 days. Considerable doubt exists as to whether these stars should in fact be classed as long-period variables, especially the first two.

In Table I counts of Cepheid variables, grouped under day-intervals, appear in columns 2, 3, and 4, for RR Lyrae, δ Cephei, and ζ Geminorum types, respectively, and are totaled in the fifth column. The next two columns contain the number of stars of the RV Tauri and semi-regular types, and the eighth column gives the number of stars marked in the Schneller catalogue as "questioned," or of the "Mira" type. The grand totals are given in the ninth column; the tenth contains the percentages of all Cepheids with periods greater than one day under the respective day-intervals. The number of variables of the RR Lyrae type, for each tenth of a day, is given in a supplementary table, Ia, together with their percentages.

TABLE Ia

RR Lyrae Type

Per.	No.	%	Per.	No.	%
0.0	3	0.4	0.7	26	3
0.1	10	1	0.8	5	0.6
0.2	14	2	0.9	1	0.1
0.3	69	9	1.0	1	0.1
0.4	233	29	1.1	0	
0.5	292	37	1.2	1	0.1
0.6	137	17	1.3	1	0.1

Frequency of Eclipsing Variables: An analysis of the eclipsing variable data in this same catalogue yields considerable information of interest. The shortest period eclipsing variable known is the faint star UX Ursae Majoris (period 0.1967 day, or $4^h\,43^m$), whose variation is of the Algol type with a depth at principal minimum of 1.04 magnitudes, and at secondary minimum a depth of 0.08 magnitude. The well-known star ϵ Aurigae has the longest known period, namely 9883 days, or 27 years. Schneller, carrying on the practice of Prager, has divided the eclipsing variables into three types, represented by such typical stars as W Ursae Majoris, β Lyrae, and Algol. The first two types vary continuously throughout their cycles, with two well-marked maxima and minima, whereas the Algol stars, in general, hve flat curves at maximum with or without a secondary minimum. As a rule, the W Ursae Majoris stars are of short period, one day or less, with a maximum frequency between 0.3 and 0.4 day. The β Lyrae-type variables, with only one less than 0.5 day, have a maximum frequency of periods between 0.5 and 0.6 day, with a second maximum between 1.6 and 1.7 days. The longest period β Lyrae variable appears to be W Crucis, with a period of 198.5 days. If the W Ursae Majoris and β Lyrae stars are joined into a single class there are no appreciable changes in the maximum frequency of periods. The Algol-type eclipsing

variables present a frequency-period curve somewhat similar to that for the U Ursae Majoris and β Lyrae stars combined, when plotted according to day-interval counts, but decidedly different when examined for decimal-of-day intervals, at least up to 4-day periods.

The Algol-type stars indicate a progressive increase in period-frequency from

TABLE II

Period	log Period	W UMa	β Lyrae	Algol	?—	Totals	Period	log Period	W UMa	β Lyrae	Algol	?—	Totals
0	9.70	114	48	87	12	261	34	1.54			2	1	3
1	0.18	2	37	192	16	247	35	1.55		1			1
2	0.40		15	149	3	167	36	1.56		1			1
3	0.54		9	94	5	108	37	1.57			1		1
4	0.65		7	56	3	66	39	1.60			1		1
5	0.74		4	36	2	42	45	1.66			1		1
6	0.81			28		28	46	1.67			1		1
7	0.88		1	11		12	56	1.75			1		1
8	0.93		2	21		23	59	1.77		1			1
9	0.98		1	12		13	60	1.78			1		1
10	1.02			7		7	61	1.79			1		1
11	1.06			10		10	62	1.80		1			1
12	1.10		1	7	1	9	73	1.87			1		1
13	1.13			6		6	90	1.96			1		1
14	1.16			5		5	96	1.98			1		1
15	1.19			2	1	3	104	2.02			1		1
16	1.22			4		4	176	2.25			1		1
17	1.24			1		1	180	2.26			1		1
18	1.27		1	2		3	197	2.29		1			1
19	1.29		1	1		2	198	2.30		1			1
20	1.31			3		3	261	2.42			1		1
21	1.33		3	1		4	605	2.78			1		1
22	1.35			3		3	732	2.86			1		1
23	1.37			1		1	972	2.99			1		1
25	1.41		1			1	4900	3.69			1		1
31	1.50			2		2	6545	3.82			1		1
32	1.51		1	1		2	7430	3.87			1		1
33	1.53			1		1	9883	3.99			1		1
							Totals		115	138	766	44	1064

0.2 day to 1.2 days, then a more fluctuating form of frequency curve, falling off to a minimum, especially after 11 days.

An enumeration of eclipsing variables according to day-intervals is contained in Table II. Columns 3, 4, and 5 refer to W Ursae Majoris, β Lyrae, and Algol types, respectively, and column 6 to those marked "?" and "—". The final totals are given in the last column. For convenience in plotting, the logarithm of the period (indicated for the half-day point of each day) is given in column 2. Algol stars total 75 per cent of all the classified eclipsing variables, W Ursae Majoris stars 11.4 per cent, and β Lyrae stars 15.5 per cent. Table IIa contains supplementary data for eclipsing variables for each tenth of a day interval up to periods of 4 days. Figure 2 illustrates the frequency curves for Algols (circles), and for W Ursae Majoris and β Lyrae stars combined (dots); the curves to the left represent day-intervals, and the inserted curve to the right, tenths of a day intervals.

Many other facts concerning both Cepheids and eclipsing variables will be found in the recently published book, "Variable Stars," by C. P. and S. Gaposchkin.

TABLE IIa

Per.	W UMa	β Lyr	Algol	Totals	Per.	W UMa	β Lyr	Algol	Totals
0.0	..	..	..	..	2.0	..	2	20	22
0.1	..	..	1	1	2.1	..	2	18	20
0.2	18	..	..	18	2.2	..	2	11	13
0.3	37	..	2	39	2.3	..	1	11	12
0.4	27	1	6	34	2.4	..	1	16	17
0.5	12	13	12	37	2.5	..	1	15	16
0.6	7	10	17	34	2.6	..	1	18	19
0.7	6	12	12	30	2.7	..	2	12	14
0.8	3	6	20	29	2.8	..	..	21	21
0.9	4	6	17	27	2.9	..	3	7	10
1.0	2	8	20	30	3.0	..	1	17	18
1.1	..	3	21	24	3.1	..	1	7	8
1.2	..	5	16	21	3.2	..	1	11	12
1.3	..	2	14	16	3.3	..	..	13	13
1.4	..	4	17	21	3.4	..	2	11	13
1.5	..	2	22	24	3.5	..	1	9	10
1.6	..	7	25	32	3.6	..	..	3	3
1.7	..	1	14	15	3.7	..	1	11	12
1.8	..	3	21	24	3.8	..	..	7	7
1.9	..	2	22	24	3.9	..	2	5	7
					Totals	116	109	522	747

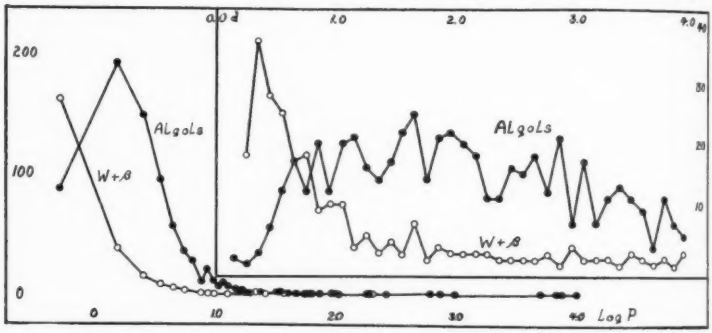

FIGURE 2
FREQUENCY OF ECLIPSING VARIABLES

Harvard-Milton Variable Star Bureau, Preliminary Results: Reference has already been made in these notes (August-September, 1938) to the proposed work of the Milton Variable Star Bureau established at Harvard for the study of variables from the extensive Harvard collection of celestial photographs. Dr. C. Payne-Gaposchkin has kindly submitted the following important and interesting facts concerning a few of the many variables already studied by the Bureau.

UW Lyrae, 1425*16*, designated as "irregular" in the catalogues, proves to be a regular variable with a period of 85 days, and a spectrum of class K. If, as is probable, it is really a Cepheid, it is the longest-period Cepheid known in the galactic system, its nearest rival being DN Arae (referred to in the first note).

SX Librae, 1436*19*, designated in the latest catalogue as "long-period?" is certainly a long-period variable as far as length of period is concerned—333 days—but it is very irregular in the matter of heights of different maxima, a characteristic that is shared by many other long-period variables, such as χ Cygni. There is a group of bright long-period variables in Libra, and from a simultaneous study of

them by the same observer on the same set of plates, it seems clear that, for these stars at least, the longer the period, the more variable the brightness at maximum.

Y Crateris, 111624, previously designated as of the R Coronae Borealis type, proves to be a well-defined variable of long-period, of unusually regular behavior, with a period of 155 days. It may be that many of the stars previously called R Coronae Borealis variables will be found eventually to belong to some other group, probably to the long-period type more than any other.

UW Bootis, 141747, although correctly classified as an eclipsing star, is found to have a period of 1.0047 days instead of 0.4401 day; to have a curve resembling Algol instead of W Ursae Majoris; a depth for the primary minimum of 0.6 magnitude, and for the secondary a depth of 0.05 magnitude. The secondary minimum is not centrally placed between the primary minima; and a careful study of all the observations suggests that the time of principal minimum is not constant, which implies changes in period. The spectrum is not far from class F.

These and many other surprising facts are being revealed by the Bureau's investigations.

Personal Note: Dr. Richard Prager, for many years Professor of Astronomy at Berlin-Babelsberg, and noted authority on variable stars and their history, has recently joined the staff of the Milton Bureau at Harvard.

Observations: In spite of the poor observing conditions reported from many stations the world over during recent weeks, sixty-three observers contributed 3500 observations, distributed as follows:

Observer	Var.	Est.	Observer	Var.	Est.
Adamopoulos	7	7	Kearons	44	69
Albrecht	3	3	Kelly	11	15
Baldwin	73	81	Kirkpatrick	18	39
Ball, A. R.	13	21	de Kock	55	244
Ball, J.	5	5	Kozawa	9	25
Bappu	34	95	Lizarraga	5	5
Bates	1	4	Loreta	146	416
Blunck	8	8	Lundquist	17	37
Bouton	57	87	Maupome	53	53
Callum	15	17	McLeod	10	10
Cameron	6	7	Meek	32	266
Carpenter	10	11	Needham	38	48
Dafter	10	26	Parker	11	11
Diamantopoulos	6	51	Peltier	78	128
Economou	12	13	Purdy	9	15
Ensor	16	16	Radamacher	4	4
Escalante	150	160	Recinsky	8	12
Fernald	46	59	Riegelman	4	4
Focas	27	43	Rosebrugh	14	20
Franklin	20	21	de Roy	13	27
Gregory	68	68	Schattle	3	3
Gomi	7	27	Seely	3	3
Hartmann	121	201	Sill	5	5
Herbig	103	279	Slocum	5	5
Hiett	16	22	Smith, F. P.	17	20
Hildom	29	50	Topham	24	24
Holmes	5	5	Webb	25	28
Holt	87	202	Weber	5	5
Houghton	55	110	Williams	5	19
Howarth	16	18	Yamada	4	11
Jones	52	149	Yamasaki	24	26

March 13, 1939.

Notes from Amateurs

Amateur Astronomers Association of Pittsburgh

A special lecture on "The Fallacy of Astrology" by Dr. J. A. Hynek, Perkins Observatory, Ohio Wesleyan University, Delaware, Ohio, was held February 9 in the Avalon Room of the Metropolitan Club in the Keystone Hotel. Open to the public it was to enlighten the uninformed and credulous as to the lack of scientific basis for assumptions of astrologers and fortune tellers in forecasting, based on the positions of the planets. That this old delusion still persists is only too evident. In fact, cheap literature on the subject is yearly produced by the millions of copies. It was a pleasure to hear Dr. Hynek and his lecture was enjoyed both by the members and public. Officers for the year are as follows: S. S. Weisiger, Jr., President; F. M. Garland, Vice President; Leo J. Scanlon, Secretary; and W. A. MacCalla, Treasurer. If you are in the Pittsburgh district and wish to join the Association, communicate with Mr. Leo J. Scanlon, 1405 East Street, Pittsburgh, Pennsylvania.

DON H. JOHNSTON.

Euclid Beach Park, Cleveland, Ohio.

Cleveland Astronomical Society

In the Physics Lecture Room, Case School of Applied Science, on Friday evening, February 17, Dr. Louis G. Henyey gave an illustrated lecture on "Interstellar Dust." Dr. Henyey is a Case graduate and is now at the Yerkes Observatory of the University of Chicago. As usual a large crowd attended—about evenly divided between the members and the general public. The lecture room at the observatory no longer is large enough to accommodate the meetings since Dr. Nassau has been so successful in obtaining well-known speakers. That tenuous interstellar dust clouds form an important part of cosmic structure was apparent from slides shown. Also the dark band through the center of a galaxy seen edgewise was explained by the fact that dust formations seem to concentrate in the center layer of a star system. That most of the apparent "holes in space" are due to dark nebulous matter obscuring distant stars was noted. While these tremendous clouds of matter are of such great extent it is well to bear in mind that they approximate a vacuum as commonly obtained on the earth so they become important only because of their great extent. The composition of these minute particles is not known exactly but they are supposed to be non-metallic. That there is some connection between dust clouds and comets seems possible—especially long-period comets—but just what this relation is will be a problem for the future.

DON H. JOHNSTON.

Euclid Beach Park, Cleveland, Ohio.

Amateurs' Observatories

The two domes which constitute our observatories are located on the bank of the Mississippi River and near U. S. Dam 15.

One building houses our largest refractor, a 6-inch Clark. It is an equatorially mounted 90-inch telescope without a clock drive. The telescope has a 2-inch finder and a slow motion in R.A. The building is of our own construction. It is twelve-sided, of number 18 sheet iron construction, and 17 feet in diameter. The dome rotates on top of a circular track, the dome is also 12-sided and two door

shutters allow an opening of 30 inches. In this building, besides the telescope, are the star charts, ephemerides, and the general library of astronomical books.

The other building used to house our 10-inch reflector of our own make, but it now has a 4-inch refractor, a Clark telescope, equatorially mounted with circles and slow motion in both axes. This is used as a guide telescope for our star cameras. Both telescopes are on 3x4x6 solid concrete piers. The building, in which the 4-inch telescope is, was the first made and is of the same construction except it has two overlapping hinged doors in the dome.

Our program is limited mostly to photographing with the star-cameras, and using a small 3-inch comet finder of f :6 ratio in searching for comets and novae. We have allowed the public free use of the telescopes for viewing the heavens and this has curtailed the little time we have for work. We belong to the A.A.V.S.O. but we have but little time for reports. After we have spent a couple of hours in exposures without clock drives we are tired out, and one of us always has to watch the shutter opening in front of the star-camera during the exposures.

We are planning a large refractor, and are now grinding an 8-inch clear aperture for ourselves. We have made quite a few mirrors for ourselves and have given a number away for others to use.

ARTHUR DE VANY and B. NORDBLOM, JR.
929 Grand Avenue, Davenport, Iowa.

Communications and Comments

Under this heading we shall publish from time to time such material as does not properly fall under any of the established headings of this journal. Here, too, may be found, when occasion arises, articles which the editor may not be willing to give sanction to but which, nevertheless, may be provocative of thought along new lines.

Concerning Meteor Radiants

In *Flower Observatory Reprint* No. 46 (from POPULAR ASTRONOMY, **46**, 1938, pp. 22-25), C. P. Olivier has presented evidence showing that certain inaccuracies occur in the positions of meteor radiants obtained from reticle observations and reduced by the use of statistical techniques. This is undoubtedly true, but there is another side to the question: the mere proof that this method of observation and reduction leads to large errors is no indication that the alternative method (direct plotting on star maps) does not lead to as large or even larger errors. Ten years' experience with the direct plotting method has convinced me that except in certain special cases to be mentioned later, the subjective element enters here to such an extent that the results are of little value. The observer who is plotting meteors directly on a star map cannot avoid knowing how the observations are progressing and hence cannot avoid unconscious prejudice regardless of how good his intentions may be.

Moreover, the accidental errors in plotting the path of a meteor are much larger than one's subjective impression of his work would lead him to believe. (This statement may be verified by comparing the independent plots of the same meteor by two or more observers, or by comparing a plotted path with a photograph. I have photographed two meteors which I have also plotted and find the average error of plotting to be about 5°, a value in general agreement with that obtained by others. *Cf.* Hoffmeister, C., *Die Meteore*, p. 13.)

The visual observer recording meteors directly on a star map can expect to obtain reliable results only on occasions when most of the meteors are evidently proceeding from a single radiant. When, on the other hand, a number of radiants are almost equally active simultaneously, a tangle of projected paths results which cannot be interpreted with certainty (*Cf.* Hoffmeister, C., *Die Meteore*, p. 64). In addition to the major showers, which of course generally fulfill the former conditions, there are rare occasions on which a minor stream will produce a shower of sufficient density to permit a relatively satisfactory determination of its radiant. If I may draw an illustration from my own work, I should like to cite a radiant at $\alpha = 34° \pm 5°$, $\delta = 2° \pm 5°$, October 25, 1937, which furnished 7 meteors in one hour, (and of these, 5 appeared within the same 10-minute period).

The individual visual meteor observer should not attempt to derive radiants from every night's observations. This must wait until it becomes possible to photograph faint meteors. The visual observer has a different, but not less important, function: he must watch until a shower occurs which is sufficiently concentrated to be certainly distinguishable; then he must be alert to record it. His attitude should be that of the comet seeker who does not expect to discover a comet every night, but who nevertheless is ever vigilant so as not to let one escape him when it does appear.

FRANKLIN W. SMITH.

Thiells, New York, February 25, 1939.

A Possible Origin of the Planets

Astronomers are generally agreed that the sun is losing mass by reason of the tremendous output of its light and heat. Also that this loss of mass reduces both the sun's diameter and its gravitational hold upon the earth, with the result that the earth is slowly receding from the sun.

These processes, of course, do not affect the earth only. They must also affect all the other planets of the solar system from Pluto to Mercury. All are slowly moving away from the sun, in obedience to its lessening gravitational pull, and conversely they were much nearer to the sun in the remote past.

If the sun is decreasing in diameter now, it must have been much larger ages ago, tremendously larger hundreds of millions of years ago, and enormously larger billions of years ago.

Having the above facts in mind the writer ventures to suggest the following as a possible process for the origin of the solar system.

We start by assuming that about one hundred billion years ago the sun was a supergiant star, having a diameter of perhaps 400,000,000 miles, which would place its boundary beyond the present orbit of Mars. We assume also that the sun's temperature was many times greater than it is now. The sun is also assumed to have been without planets or other attending bodies.

This massive sun, in obedience to the laws of physics, rotated upon its axis. It rotated faster and faster, until it took the shape of a flattened globe, with its equatorial diameter greatly exceeding its polar diameter. As the centrifugal speed reached a critical limit a huge mass of material was hurled from the sun into space. This mass, with its centrifugal impetus, revolved around the parent sun in the same direction that the sun rotated, and in the course of time it solidified and became the outer planet Pluto.

It may be questioned whether at that time the sun could hurl into space a mass of material large enough to form a planet. But attention is called to the fact that

at the present time the sun is still throwing masses of material into space.

In Sir James Jeans' book "Through Space and Time," there is a series of six photographs showing a prominence being hurled from the sun into space. In less than two hours the prominence had risen to a height of 567,000 miles, at an average speed of about 300,000 miles an hour, or 83 miles a second.

Also in the June, 1938, number of the *Publications of the Astronomical Society of the Pacific* there is a series of six photographs by J. O. Hickox of a prominence being hurled from the sun on March 20, 1938. These photographs followed the prominence until it was nearly one million miles above the sun. This height was reached in 2 hours, 19 minutes. The speed increased from 43 miles a second to 124 miles a second.

Material hurled from the sun in this way of course never returns to the sun. What becomes of it? Perhaps it is the source of the countless meteors that daily fall on the planets.

If the sun has such power at this time what must have been its power aeons ago, when it was a supergiant?

After the first mass of material was hurled from the sun there followed a long period of time, perhaps billions of years, during which the new planet Pluto revolved about the parent sun. It receded farther and farther as the sun lost mass and gravity by reason of its enormous output of heat and light. The sun continued to rotate upon its axis, and its diameter decreased steadily.

Then once more the centrifugal speed of the rotating sun reached a critical limit, and another huge mass of material was hurled from the sun to form the next planet Neptune. This also revolved around the parent body in response to its axial rotation.

Two planets now revolved around the sun. They were followed at extremely long intervals of time by other planets being ejected from the parent sun, until all the planets came into being. In this process of forming the planets the sun became smaller and denser, until by the time Mercury was formed the sun's eruptive power was so weakened that no *large* masses could be thrown off into space, and it seems unlikely that an intramercurial planet will ever come into existence.

It is difficult to account for the asteroids. One suggestion is that when a mass was ejected from the sun the gravitational power of Jupiter was sufficient to break it up into small pieces, and these pieces are now revolving around the sun as the asteroids.

As for the satellites it may well be that they were ejected from the planets in the same way that the planets were ejected from the sun. Many astronomers affirm that the moon was born of the earth. If so, surely it cannot occasion any surprise that other planets should have satellites, and some of them several satellites.

This, it is suggested, is the process by which the solar system came into being. It accounts for the planets all revolving around the sun in the same direction, and in the same plane, for as the sun was a flattened globe or disk the planetary material would be hurled from the equatorial edge, and should quite naturally revolve in the direction of the rotating sun. Also it accounts for the planets all rotating in the same direction, for when separated from the parent body they kept up the rotating action of the sun. Also in the main the satellites, being ejected from the planets, revolve and rotate in the same direction. Any irregularities in the motions of the planets or satellites can fairly be attributed to small secular changes over a very long period of time.

It is to be noted that the assumption of the sun originally extending beyond

the orbit of Mars is purely arbitrary. It may have extended farther or not so far. *What is especially emphasized is that, since their creation, all the planets have been receding from the sun, are receding now, and will continue to recede.* This results from the sun's steadily losing its mass, which in turn reduces both its diameter and its gravitational force.

The sun originally was probably a very attenuated body as compared to its present condition. It therefore would lose diameter and gravitational force more rapidly in its early stages than it does at the present time.

It is more than likely that in addition to ejecting material to form the planets, the sun was constantly losing mass by material being thrown off from all parts of its surface, similar to the prominences that are being thrown off today. This loss of mass in long periods of time must have been considerable, and it can reasonably be assumed to have played an important part in decreasing the diameter of the sun, and in diminishing its gravitational power.

The life history of the sun, from the time when it had a diameter of 400,000,000 miles to its present diameter of less than one million miles, has taken a long period of time. How long it would be impossible to estimate. We have mentioned a hundred billion years. It may have been longer. For the intervals between the birth of each of the nine planets must have been long enough to allow the preceding planet to recede a suitable distance from the sun, and the sun to store up enough energy for ejecting the succeeding planet.

As far as we know the earth is the only planet that is now inhabited. But is it not conceivable that every planet either has supported life in the past or will support life in the future?

All the planets were born of the sun. They should all, therefore, contain the same physical and chemical elements that abound in the earth. All that would be needed in any planet to support life is for it to attain a suitable range of temperature. Then the processes of evolution would begin, resulting in intelligent life.

The outermost planet should naturally be the first to reach that condition and be inhabited. But after many millions of years, and continuing to recede from the sun, it would become too cold to maintain life and life would cease on that planet.

After a long period of time had elapsed the next planet would go through the same course of procedure. Then the others in the order of their creation, but with long intervals of time between each one. Now it has come to the earth to carry along the life cycle. When life has ceased on the earth, as it will when it has receded far enough from the sun, Venus will then be in a suitable range of temperature for supporting life, and life will appear there. But in the course of time it too will become so cold that life will cease.

Then Mercury, which is also receding from the sun, will in time come into the proper range of temperature, and life will come to the innermost planet. This will be the last stand of intelligent life in the solar system, for when life ceases on Mercury, as it will when it also shall recede far enough from the sun, life will cease in the entire solar system.

If the process that has been outlined seems possible, there might be many systems such as ours in the universe, for there are a great number of supergiant stars in our galaxy. And the systems should be in all stages of development, from some in the earliest beginnings to those that have finished their course, and are travelling through space devoid of all life.

ALBERT J. BROOKS.

1150 Sterling Place, Brooklyn, New York, March, 1939.

General Notes

Dr. Frederick C. Leonard, Chairman of the Department of Astronomy of the University of California, Los Angeles, will be visiting professor of astronomy in the summer session of the University of British Columbia, Vancouver, Canada, July 3 to August 18, 1939, while Dr. Daniel Buchanan, Dean of the Faculty of Arts and Science and Head of the Department of Mathematics of the University of British Columbia, will be visiting professor of astronomy and mathematics in the summer session of the University of California, Los Angeles, June 26 to August 4. A similar exchange of these two professors was made in the summer of 1937.

James Stokley, associate director, in charge of astronomy, of The Franklin Institute of Philadelphia, has been appointed director of the new Buhl Planetarium and Institute of Popular Science in Pittsburgh. The Board of Managers of The Franklin Institute has accepted his resignation, effective April 15, and immediately thereafter he will assume his duties in Pittsburgh.

The Buhl Institute is being erected by the Buhl Foundation, at a total cost of $1,070,000. The building, now nearing completion, is located on Pittsburgh's North Side at Federal and West Ohio Street. The site, furnished by the municipality, was formerly occupied by the old Allegheny City Hall. In addition to a Zeiss planetarium, fifth in the United States, and a public observatory, the building will include a main exhibit hall 150 feet long by 33 feet wide, five smaller halls, a lecture hall seating 250 persons, space for amateur telescope makers, offices, shops, and preparation rooms.

Wherever possible, exhibits will be moving and operable by the visitor. They will show the development and recent achievements of modern science, with its latest applications. Displays will be changed frequently to keep up to date and to maintain interest. The Institute is expected to open in September.

Mr. Wagner Schlesinger, assistant to Mr. James Stokley since the opening of the Fels Planetarium in 1933, has been elected by the Board of Managers of The Franklin Institute to become Mr. Stokley's successor as Associate Director, in Charge of Astronomy. This appointment will date from April 15, the date on which Mr. Stokley's resignation becomes effective.

The Rittenhouse Astronomical Society of Philadelphia held a meeting of the Society on Friday, March 10, in the Hall of The Franklin Institute. An address was given on the subject, "Navigation: Sea and Air," by Lt. Comdr. J. L. Woodruff, U.S.N.R.

Splendid Auroral Display*

A truly magnificent display of the Aurora Borealis was seen in Cleveland on September 27, 1938, between 10:45 and 11:05 P.M., E.S.T. Dr. J. J. Nassau, professor of astronomy at Case School of Applied Science, said he had never seen a comparable display in Cleveland; and I had never before seen anything like this exhibition. Activity had begun at 8:30 but suddenly became marked at about 10:45. The appearance at first was that thin clouds covered the sky. The numer-

*Somewhat belated but still worthy of publication for the sake of record. ED.

ous bright and extensive streamers converged to a point a few degrees south-southwest of the northwest star in the Square of Pegasus. Near this point was the greatest activity. This point did not shift its position between 10:45 and 11:05. The streamers in this region were certainly brighter than the Milky Way. Some of the streamers extended more than a hundred degrees to the northern horizon; others reached to within thirty degrees of the southern horizon. I think that at 10:45 streamers covered three-fourths of the sky. Flashes of light and rapid scintillations were seen; at times it almost looked as though waves of light were travelling along the streamers. Most of the streamers were white, but a dull red color was seen near the northeast horizon during part of the display. Activity was already less marked at 10:50; at 11:05 most of the streamers were very faint, and the converging-point could no longer be recognized. After 11:05 the display was not unusual.

WALTER H. HAAS.

2009 Taylor Road, East Cleveland, Ohio, October 12, 1938.

A Bright Aurora

A bright Aurora was observed here on the evening of February 24. It was perhaps the best display of the past two or three years, though a five-day moon interfered considerably and there were but few conspicuous streamers and pulsations. At 8:45 E.S.T., a radiant was estimated in R.A. 6 hours 20 minutes, North Declination 28 degrees.

L. C. PELTIER.

Delphos, Ohio, February 26, 1939.

Wagner Schlesinger, New Director of the Fels Planetarium

The man-made skies of the Fels Planetarium will have a new director next month, when Wagner Schlesinger takes over the post held, since the Planetarium was opened, by James Stokley. Mr. Stokley has been named to head the new Buhl Planetarium and Institute of Popular Science in Pittsburgh.

Announcement of Mr. Schlesinger's appointment was made yesterday by Dr. Henry Butler Allen, secretary and director of The Franklin Institute. In addition to heading the Planetarium he has been named as associate director in charge of the Astronomical Section and the Photographic Section, and will also supervise the operation of the Institute's seismological station. He has been a lecturer in the Planetarium ever since it was opened, more than five years ago, and, before that, was lecturer at the Adler Planetarium, Chicago.

Since his birth, April 5, 1901, he has been steeped in an atmosphere of astronomy. His father, Frank Schlesinger, one of the great astronomers of the world, is director of Yale University Observatory. He spent his infancy near Yerkes Observatory, Williams Bay, Wisconsin, and went to school in Pittsburgh, spending a great deal of time around the telescopes of Allegheny Observatory. Here, when only nine years old, he ws assigned to preside over a small telescope when popular interest in Halley's comet was at its height. He attended the Pittsburgh public schools and Swarthmore Preparatory School. He spent one year at the University of Pittsburgh but was graduated from Yale in 1923, after having majored in physics and mathematics. While an undergraduate, and for several years later, he was in charge of visitors' nights at the Yale Observatory.

After leaving college he was connected with the radio engineering department of the General Electric Company, in Schenectady, and later he joined the experimental staff of the Winchester Repeating Arms research laboratories, in New

Haven. He had three ways to spend his time—researching in ballistics for his vocation, explaining the fascinations of astronomy to the public at the observatory as an avocation, and shooting small-bore rifles as a pastime. This had always been a favorite diversion, but he soon became one of the foremost marksmen in the country. He was a member of a number of championship rifle teams, including that representing the United States in international competition for the Dewar Trophy in 1928.

In 1931 he was appointed to the staff of the Adler Planetarium, Chicago, where he delivered about 600 lectures before and during the World's Fair. When the Fels Planetarium was opened he was invited to join its staff. He has delivered almost 2000 lectures in the Planetarium since coming to The Franklin Institute.

One of his favorite pastimes is the creation of new devices for any need which may happen to arise. The result is that many of the special effects which have been seen in a number of different Planetarium demonstrations have been developed by him. Some of his instruments will be seen at work in the April demonstration in the Fels Planetarium, to be devoted to "A Trip to the Moon."

He is an active and enthusiastic amateur photographer. He is a former secretary of the Miniature Camera Club of Philadelphia.

Unmarried, his home is at 1612 Pine Street, Philadelphia.

Philadelphia, Pennsylvania, March 23, 1939.

Book Reviews

The Sun. *Its Phenomena and Physical Features,* by Giorgio Abetti. Translated by Alexandre Zimmerman and Frans Borghouts. 157 illustrations, 360 pages. (Lockwood, London; Van Nostrand, New York; 1938. $5.00.)

The value of Professor Abetti's chapter on solar physics in the *Handbuch der Astrophysik* was immediately recognized. In response to requests for a less technical volume covering the entire field of solar physics, *Il Sole* appeared in Italian in 1936. The translated edition of 1938, *The Sun,* is the most complete and compact volume in English on the subject and came when an up-to-date authoritative volume was greatly needed. The work was revised and brought up to date only in parts according to the author. One of the omissions is lack of reference to instrumental equipment for applying motion picture technique to disk and prominence phenomena and new results thus obtained.

The introduction moves directly from the worship of the sun, by way of Galileo's observations, to a good summary of fundamental physical facts including mean distance, apparent size, dimensions, mass, density, and surface gravity. The distance of Alpha Centauri, which is termed the nearest star, rather than Proxima, is compared with the sun's distance; but the ratio, 4.3 light-years to 498 seconds, seems to confuse the unit of distance with the unit of time.

Professor Abetti is at home in Chapter I, "How the Sun is Observed." Photographs and diagrams of instruments from eye-pieces to Hale's spectrohelioscope are included, but we looked in vain for the spectroheliokinematograph, which was described in 1933. Full justice is done in later chapters to Deslandres' *spectroenregistreur des vitesses* and to Lyot's coronagraph. Chapters II and III are out-

standing: What is seen on the sun by direct visual and photographic observation, and by spectroscopic observation. The first three chapters cover the greater part of the contribution in the *Handbuch der Astrophysik*. The complex phenomena associated with sunspots are described and analyzed with great thoroughness. The well-organized index contains twenty-five topics under sunspots with thirty-five references. There is an excellent usable reproduction of the solar spectrum from 3000 A to 6600 A. In the list of elements in the sun barium has unfortunately taken the place of boron. Possibly caesium and tantalum might be included, at least among the elements probably present. The author twice refers to caesium as though it exists in the sun; while Kiess and Stowell, 1934, made a good case for tantalum. Mention is made of the record height of the prominence of September 17, 1937, one million kilometers, since exceeded; but the record speed 728 km/sec was omitted. Moot questions are dealt with cautiously and judiciously with an occasional remark such as, "still to be accounted for by future experimental and theoretical researches."

The historical approach is well utilized, *e.g.*, in the subject of eclipses. Mitchell's slitless flash spectra and results are compared with Menzel's conclusions from Campbell's slit and moving plate method. Types of the corona are illustrated by Lockyer's drawings rather than by selected photographs. Confidence in Lyot's method without an eclipse to add data regarding the corona lends hope to the problem of its constitution. We did not find reference to the interference method of attacking the "green line." Regarding theories on the constitution of the sun the success of Bjerknes' hypothesis in explaining spot phenomena by stratified circulation is well presented and appears "dynamically and thermodynamically possible." The origin of solar heat considered a mystery is attributed to atomic nuclei, but transformations suggested by Bethe and others are lacking. The quantitative relation between mass and radiant energy, one gram equivalent to 9×10^{20} ergs, is omitted. Planck's law of radiation and Saha's ionization formula are applied elsewhere qualitatively but not quantitatively.

The instruments and methods for determining the solar constant are well described and an attempt is made to find the causes of its chief variations. Departure from black-body distribution of energy in the solar spectrum is accepted and differences between center and limb are presented. The so-called temperatures of solar regions determined by various methods are tabulated. The result by the Stefan-Boltzmann law for the reversing layer, 5770° A, heads the list.

Six and a half pages on "The Sun Among the Stars" are packed with information including relation to stellar spectral class, apparent and absolute magnitudes both visual and photographic, other physical properties, place in the "main sequence" or dwarf branch in evolution, age and future in the stellar time-scale, also position and motion in the galactic system. The last chapter discusses correlations between solar and terrestrial phenomena. The earth's magnetic fields, atmospheric electric currents, polar aurorae and certain meteorological phenomena are attributed with certainty to changes in the sun, while ten other phenomena are probably related. A careful comparison of related solar and terrestrial changes leads to the conclusion that the sun's action is not uniform in all directions. The chapter ends with a brief discussion of the utilization of solar heat. The reader, however, will evaluate and appreciate the work not from the utilitarian point of view, but from the large amount of scientific material, thoroughly analyzed, logically arranged, and well presented in English, which is not too technical for serious students of *The Sun*.

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Everyman's Astronomy, by Mary Proctor. (The Scientific Book Club, 121 Charing Cross Road, London, W. C. 2. Price 2/6.)

This is a book that should recommend itself highly to the layman or the beginner in astronomy, who, with limited means, yet unbounded enthusiasm, desires to know something of the things that he might immediately see in the heavens. Within its 246 pages are to be found the descriptions of a wealth of different objects that can be seen either with the naked eye or with a small telescope. Field glasses are recommended in several cases.

The book is, of course, entirely non-technical. The author, however, has managed very cleverly to tie the subjects under discussion in with the wider realm of scientific investigation. She brings in just enough of this extra material to make the subject seem worth while. Some of the chapters have a practical application, others are of a purely speculative nature, capturing something of the wonder and feeling of awe that no true lover of the stars should ever lose. There is enough of each of these two types to make the book very interesting reading for the layman, who, knowing nothing of the subject of *scientific* astronomy, and caring about as much, desires to broaden his general knowledge of some of the more popular aspects of the subject.

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Galileo and the Freedom of Thought, by F. Sherwood Taylor. (C. A. Watts & Co., Ltd., Fleet Street, London, E. C. 4, England. 7s 6d.)

Every student of the natural sciences quite early in his career necessarily comes into contact with the work of Galileo, for it was he who in his day insisted upon the superiority of facts arrived at as a result of experimentation over those established by the dictum of authority. It was this point of view which made his life one of constant struggle and conflict and which, also, has made his name immortal. The history of the gradual supplanting of traditional beliefs by methods which are taken for granted in our day has often been told. The central figure in all such accounts is Galileo (1564-1642). Much has been written on both sides of the controversy, and doubtless in many instances both sides have been overstated. Living three centuries later we are in a position to evaluate the facts in an unprejudiced manner and therefore to arrive at more just conclusions.

The book before us gives, as a background, a description of the world at the time Galileo lived, an account of the education of Galileo and his work in physics and astronomy, emphasizing especially those aspects of his work which brought him into conflict with the established authorities. It also gives authoritative English translations of much of his writing which bears on the central theme. In a word, the facts are placed before the reader and he is permitted to draw the conclusions which seem to him to be warranted.

In the review of this book one must not overlook the somewhat parallel situation which exists today. Again in some quarters the freedom of thought is in jeopardy. Such a situation gives this volume its timeliness and lends a deeper significance to it than the mere historical facts would otherwise have.

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